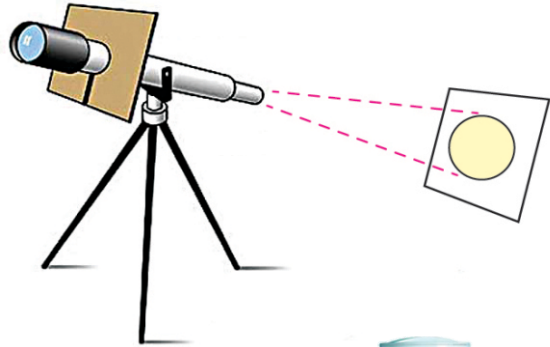
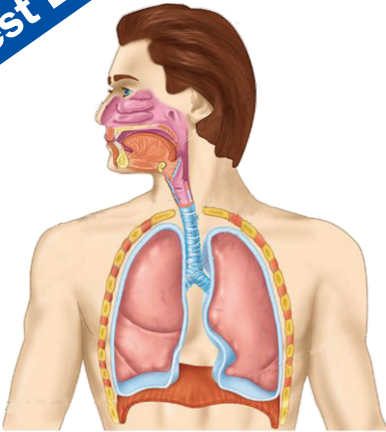
SCIENCE

FOR CLASS VII

7

Test Edition

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Preface

It is a matter of great pleasure and satisfaction for me to iterate that the Sindh Textbook Board has been providing the students of the entire Sindh province, with textbooks of worthy standard from the point of its inception, till now. On one hand, these books are quite affordable; on the other hand, their publication and availability is being managed in a timely and efficient manner.

The main ideology behind these textbooks is that they must contain knowledgeable, qualitative material in order to impart in our students, the skills that can help them compete in today's ever changing and challenging world. The present global scenario demands that first and foremost, our new generation must be well conversant with the Islamic ideology; then it must possess an exemplary character, a high degree of patriotism, and a sense of responsibility, brotherhood, fraternity and equality. The possession of all these qualities will assist them in their studies in general. However, acquisition of these skills is all the more important particularity in science teaching and learning, if the students are to actively participate in new scientific research and inventions, and develop awareness, soundness of mind and a progressive mind set.

Our students will be able to achieve success and economical stability and lead a prosperous and successful life, only when they are able to master these skills. Along with these skills our students will have to develop inquiry, communication, critical thinking and problem solving skills for a bright future. Having a bright future, they will be able to ultimately hold the reins of their country and provide it the much needed prosperity and economic soundness. They will become model citizens of their country and nation in shape of learners, implementers and innovators.

With objectives and intentions of such noble national spirit, the Sindh Textbook Board is introducing this book of **"Science Grade-7"** for new entrants in the field of education. This book has been written by well-experienced authors and reviewed by senior educationists in accordance with the "New Curriculum 2006" for inclusion in the syllabus. Thus, the Sindh Textbook Board is quite hopeful that the teachers, students and other respective stakeholders will benefit from this book.

Lastly, it is requested that in case there are any concrete recommendations(s)/suggestions from your side with reference to the material contained in this book, feel free to convey them to us, so that they can be incorporated in the subsequent edition.

The Chairman
The Sindh Textbook Board, Jamshoro.

بِسۡمِ اللّٰہِ الرَّحۡمٰنِ الرَّحِیۡمِ

1 HUMAN ORGAN SYSTEMS

In the previous class you have studied about the cells, tissues, organs and functions of the major systems in the human body. You have also studied that different systems in the body co-ordinate their activities. Now you will study the structure and function of the digestive system.

Have you ever observed what happens inside our body, when we take a first bite of food? Any time we smell or taste or even think about good food, we feel some fluid inside the mouth. Where does this fluid comes from? What is the role of this fluid while eating?

In this Chapter you will learn about:

- Digestive System
- Disorder of Digestion (Constipation and Diarrhea)
- Respiratory System
- Common Diseases of Respiratory System

All the students will be able to:

- ✓ Describe various components of Human digestive system.
- ✓ Describe digestion and its importance.
- ✓ Describe how digestive system helps in the digestion of various kinds of foods.
- ✓ Identify common disorders of the digestive system.
- ✓ List the factors that lead to constipation and diarrhea, and the measures that can be taken to prevent them.
- ✓ Describe the mechanism of respiration in humans.
- ✓ Differentiate between breathing and burning processes.
- ✓ Identify the common diseases of respiratory system and discuss their causes and preventive measures.

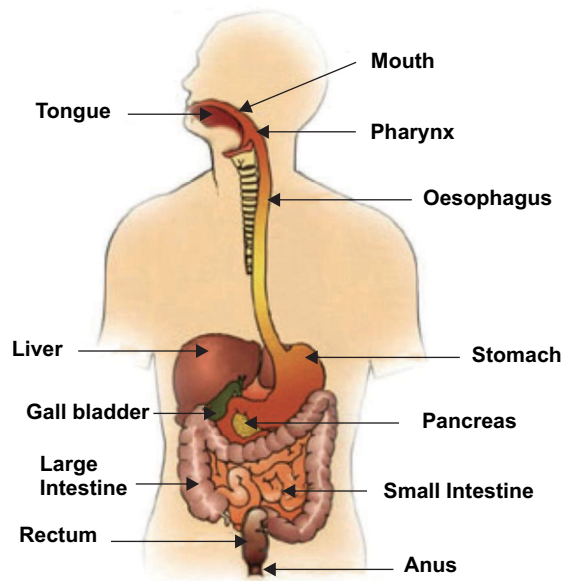



Figure 1.1 Human Digestive System

EXPLORING DIGESTION

Have you ever seen athletes take glucose solution before their races? Why?

HUMAN DIGESTIVE SYSTEM

- ✓ Describe various components of Human Digestive system.
- ✓ Describe digestion and its importance.
- ✓ Describe how digestive system helps in the digestion of various kinds of foods.

Take a bite from a piece of bread and chew it for some time.

You will find that the large pieces of bread breaks into smaller pieces. Is it necessary to convert the food into small pieces? Which part of our body performs this activity?

Food cannot go straight to the cells in the different parts of your body. It has to be broken down into smaller substances that can be absorbed into the body cells. Many organs of your body work together to achieve this goal. These organs work together to make up the digestive system and perform digestion.

"The large and complex food particles cannot enter into the cell without broken down by our body into smaller, simpler and diffusible form. This process of breaking down food into simple and diffusible molecules is called digestion."

DO YOU KNOW?

Why do we need food?

Organisms need food because food contains:

- Useful chemical substances, called nutrients provides.
- Energy Important for activities for survival like movement, growth, maintains good health, etc.

Digestion are of two types;

- **Physical digestion** is the mechanical breakdown of food into smaller pieces. This digestion provides large surface area for enzyme action.
- **Chemical digestion** is the break down food through enzymes (consists of protein molecules which speed up the rate of chemical reactions)

Steps of digestion;

There are five steps of digestion;

- Ingestion; taking of food inside the mouth.
- Digestion; breakdown of large food particles into small particles.
- Absorption; these small particles can easily diffuse through the walls of the alimentary canal into the blood stream.
- Utilization of food for cell processes.
- Egestion; elimation of undigested food.

EXPLORING DIGESTION

Which organs of the digestive system come in contact with food, and what are some of their digestive functions?

INVESTIGATE

"YOU ARE WHAT YOU EAT"

Have you ever heard this expression? Explore the working of digestive system while eating junk food and healthy food.

Two groups of organs compose the digestive system: the alimentary canal and the accessory digestive organs.

The alimentary canal is a continuous tube, extending from the mouth to the anus. The length of this tract is about seven meters in a living person. It consists of mouth, pharynx, oesophagus, stomach, small-intestine, large intestine and anus.

The accessory digestive organs include the teeth, liver, gall bladder and pancreas.

Your food usually takes 24 to 30 hours to complete its journey inside your body. So when you are having your today's lunch, your digestive system is still working on the lunch that you ate the day before.

Let's take a trip round the alimentary canal.

Mouth:

The organ of digestive system in which both chemical and physical digestion takes place, in the mouth. The mouth consists of cheeks, lips, teeth, tongue, etc.

"Mechanical digestion in the mouth results from chewing, tearing and crushing by teeth, which helps food to get easily mixed with saliva. Saliva starts the chemical digestion of carbohydrates (starch). As a result, food is reduced to a soft and flexible semi-solid food called bolus, easily swallowed by tongue and move towards oesophagus."

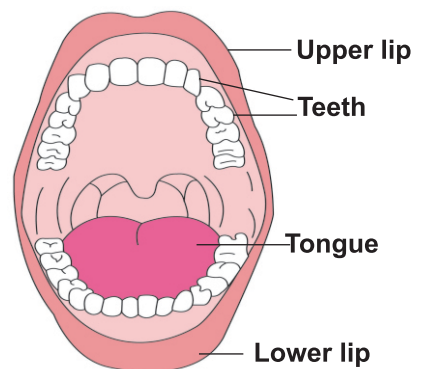



Figure 1.2 Mouth

Teacher Note: The teacher should show the model of human digestive system. Ask students questions related to main components of system during observation. Teacher also helps students to correctly identify the location of digestive organs and ask them to draw the diagram of the digestive system in their notebook.

Table 1.1: Summarizes the digestive activities in the mouth.

Structure	Activity	Result
Cheeks and lips	Keep food between teeth	Foods uniformly chewed
Walls of the mouth	Secrete saliva. Salvia contains enzyme.	Saliva softens, moistens and digests food Starch $\xrightarrow{\text{enzyme}}$ Small glucose molecules
Tongue	Consists of taste buds	Identify different food tastes
Teeth	Cut, tear and crush the food	Solid foods reduced to smaller particles for swallowing

ACTIVITY 1.1 Investigating Oral Cavity:

What I need:

- A piece of roti for each student.
- Precautionary measure:

Wash your hands thoroughly before starting the activity.

Figure 1.3 Traditional Roti

What to do:

S. No	Investigation of Oral Cavity	What I observed
1	How many teeth do you have?	
2	Why do you move your tongue during eating?	
3	What will happen if you do not move your tongue during chewing?	
4	Even before placing the piece of roti in your mouth your mouth became watery. Where this juice is coming from? Place your finger under your tongue and feel. Now place piece of roti in your mouth and hold it in mouth for few minutes.	

S. No	Investigation of Oral Cavity	What I observed
5	What happened to roti, when you hold it in your oral cavity? Why did it start to get softer? What did you taste? Did the taste changed? Did it become sweet? Did the roti get soft in your mouth even if you were not chewing? Yes/No, Why?	
6	Chew the roti and record your observations. Did you notice any change in taste after chewing for a while? Why?	
7	Why does a piece of roti become wet on chewing and it tastes sweet?	
8	Where do you think the digestion begins?	
9	What did you conclude from this activity about the beginning of chemical and mechanical digestion of food?	

Oesophagus (food pipe):

Oesophagus acts as a pathway and transports the food from pharynx to stomach. Bolus is pushed from oesophagus by a wave like pattern movement. No digestion takes place here.

Stomach:

From the oesophagus bolus enters into stomach. Stomach is a J-shaped muscular bag. The walls of the stomach release gastric juice. This juice contains

DO YOU KNOW?

- **Pharynx and Swallowing:**
  Pharynx is a funnel shaped muscular organ that connects mouth to the oesophagus (digestive organ) as well as larynx (respiratory organ). Muscular contraction of the pharynx helps to propel food into the oesophagus and then into the stomach. This movement of food is achieved by the act of swallowing.
- **What does epiglottis perform during swallowing?**
  As larynx is in front of the oesophagus so there is a possibility food enters into the respiratory track during swallowing. This is usually prevented by a flap like structure, epiglottis.

an acid called hydrochloric acid (HCl), water and enzyme. The enzyme converts the large protein molecules into small protein molecules. HCl softens the food and also kills the germs which are present in the food.

INVESTIGATE

HCl in stomach also damages the walls of stomach that cause stomach ulcer. Find out about the cause and preventive measures of ulcer.

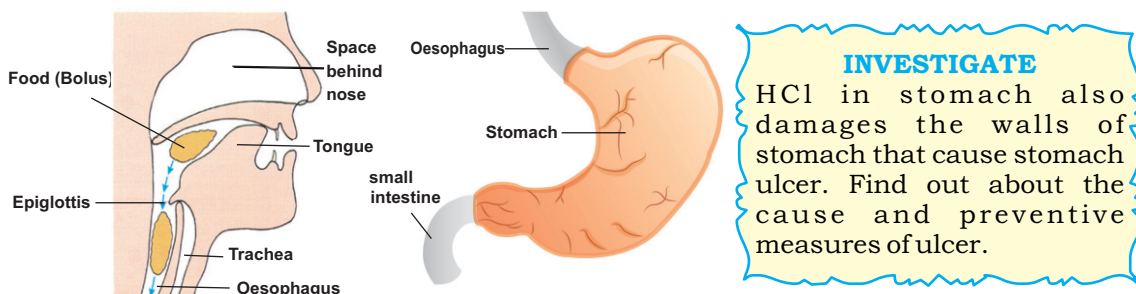



Figure 1.4 Food swallowing process and Stomach

Mechanical digestion in the stomach results from mixing waves, in which bolus is completely mixed with gastric juice.

Gastric juice starts the chemical digestion of protein. As a result, bolus is converted into a semi liquid food called chyme.

Food is held in the stomach for several hours. Gradually the stomach empties its contents into the small intestine.

Table 1.2: Summarizes the digestive activities in the stomach.

Structure	Activity
Muscular walls	Contraction of muscles generates mixing waves
HCl	Softens the food Kills the germs present in the food
Enzyme	Large protein molecules $\xrightarrow{\text{enzyme}}$ Small protein molecules

EXPLORING DIGESTION

If food moves down the oesophagus because of gravity or by wave like movement then what would happen if a person stand on his head?

DO YOU KNOW?

- **Liver and pancreas:**
  Both the liver and pancreas play a role in digestion. Without their secretions digestion remains incomplete. As liver contains gall bladder which stores bile. However the food does not pass through these structures that's why they are not the part of alimentary canal.
- **Obesity:**
  Obesity is the most common nutritional disorder. If energy input as a result of eating is greater than energy used, the extra energy is stored as fat so become overweight or obese. An obese person is much more likely to suffer from high blood pressure, cancer, stomach disorder.

Small Intestine:

Small intestine is a long, highly coiled narrow tube of six meter average length. As the chyme enters in the small intestine, it receives bile from the liver and pancreatic juice from the pancreas.

Bile is a greenish-brown juice, secreted by liver and stored in gall bladder. It helps to breakdown large sized fats into smaller pieces so that fats can be digested faster by enzymes.

Pancreatic juice is secreted by pancreas. This juice contains enzymes which help to digest proteins, fats and carbohydrates.

The small protein molecules are now broken down into amino-acids; simpler and diffusible form of proteins. The semi-digested carbohydrates are converted into diffusible sugars and fats are broken down into glycerol and fatty acids. The muscular action of small intestine mixes the food with bile and pancreatic juice.

Here the digestion is completed. At the end of the small intestine, the digested, soluble and diffusible components of food now diffuse through the walls of the small intestine into the blood stream. This process is called absorption.

Absorption only occurs in small intestine as its wall consists of many folds that provides larger surface area. Its walls are completely surrounded by capillaries for maximum absorption.

The absorbed food is utilized in the body, like glucose used in the respiration process. Amino-acids, fatty acids and glycerol are used in the formation and growth of cells.

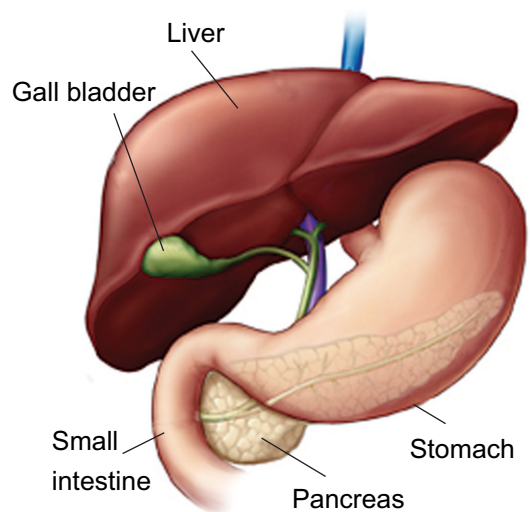



Figure 1.5 Small intestine along with liver and pancreas

Table 1.3: Summarizes the digestive activities in the small intestine.

Structure	Activity	Result
Small intestine	Muscular activity	Mixes the food completely with juices. Also speed up the digestion
Liver	Bile	Breakdown fats into smaller pieces so that fats can be digested faster by enzymes
Pancreas	Pancreatic juice	Small protein molecules $\xrightarrow{\text{enzyme}}$ Amino acids Semi-digested carbohydrates $\xrightarrow{\text{enzyme}}$ Diffusible sugars Small fats pieces $\xrightarrow{\text{enzyme}}$ Fatty acids and glycerol

Large Intestine:

The undigested, non-diffusible and insoluble components of food moves towards the last part of digestive system called large intestine.

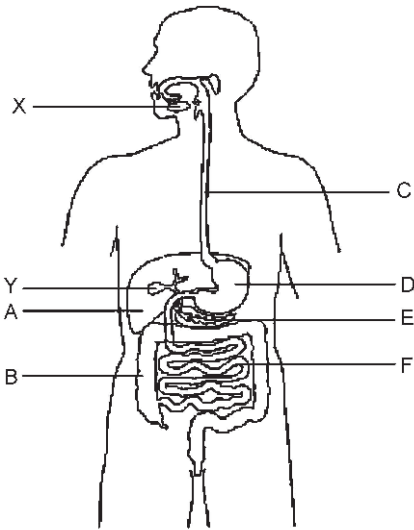
It is shorter but much broader than the small intestine. It is a tubular structure, which is on average 1.5m long with a large diameter; here the water and mineral salts are absorbed.

DO YOU KNOW?

❖ **Appendicitis:**
Large intestine contains finger like projection called appendix. It plays no role in digestion but can become infected and inflamed that cause appendicitis.

The minerals are absorbed with the help of some friendly bacteria which live here. All the non-diffusible components of food move towards **rectum**. Here the undigested food is converted into faeces which are removed from the body by an opening called **anus**.

ACTIVITY 1.2:
Imagine you are a medical student. Your teacher has assigned you to analyse the human digestive system by using graphic organiser. Here are the things you may need to do.

- Carefully observe the model of human digestive system.
- Label the diagram. Also draw a neat diagram to learn how these organs link to each other to form a system.
- Identify each organ of the system.
- Write down the function of each of the organs.
- Discuss with your teacher what would happen if the organs were missing.

Space for Labelling :

A =

B =

C =

D =

E =

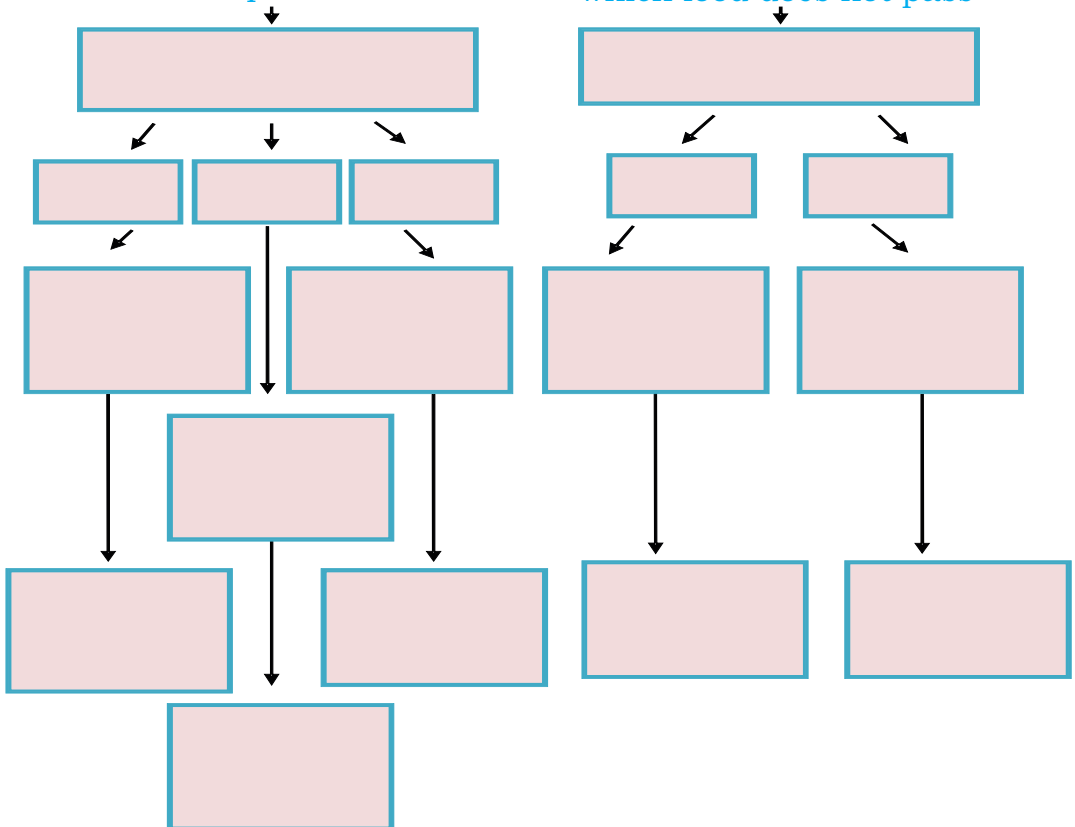
F =

X =

Y =

Human digestive system

A tube through which food passes

Structures through which food does not pass

DISORDERS OF DIGESTION

✓ Identify common disorders of the digestive system.
✓ List the factors that lead to constipation and diarrhea, and the measures that can be taken to prevent them.

INVESTIGATE
Find out the causes of diarrhea other than contaminated food.

What happens when we eat any contaminated food? Does it affect our digestive system? It may cause any damage to our system due to which digestive system does not function properly. Some of the digestive tract disorders are diarrhea, food poisoning, vomiting, ulcer, constipation, obesity and malnutrition. Most common disorders are discussed below.

Diarrhea:

Have you ever heard about loose motion? It is medically termed as diarrhea. It occurs due to fast downwards rhythmic action of digestive tract. The reasons include presence of micro-organisms in the contaminated food and water.

It might also occur because of abnormal secretion of juices. This may cause loss of body water (dehydration) and salts. This loss disturbs the normal body functions, consequently the person feels weak.

Constipation:

It is the reverse process of diarrhea in which the rhythmic action of digestive tract becomes slow. The undigested food remains in rectum for long period where extra absorption of water occurs. As a result the faeces turn into hard mass which are difficult to pass out and cause pain.

DO YOU KNOW?

How diarrhea and constipation can be avoided?

❖ **Diarrhea**
- Avoid drinking contaminated water.
- Always use boiled/filtered water.
- Use properly washed fruits and vegetables.
- Wash your hands before eating food.
- Use properly washed utensils.
- Don't use prolonged improperly stored food.

❖ **Constipation**
- Drink large amount of water.
- Use food containing dietary fibre.
- Process of egestion must be done properly on daily basis.

ACTIVITY 1.3: ROLE PLAY ACTIVITY

- Teacher will form groups of six students in a class.
- Each disorder (either constipation or diarrhea) should be taken as a character.
- Ask each member to find out the (causes, prevention and control) among the group members.
- Use headband or tags (made from chart paper) to show the name of the role you are playing.
- Learn your dialogues.
- Each group will present their role play in front of whole class.

RESPIRATORY SYSTEM

- ✓ Describe the mechanism of respiration in humans.
- ✓ Differentiate between breathing and burning processes.

EXPLORING DIGESTION

Why does respiration take place in every living cell all the time?

Do you think, while you are sleeping, you probably don't need energy?

When we consider ourselves, we only link the word energy with doing exercise, playing games, etc. Your body is doing a lot of work while sleeping, like breathing, beating of heart, movement of food in alimentary canal, etc. All these processes require energy.

In the previous class you have studied how living organisms produce energy. You have also studied the major organs of the respiratory system that provides oxygen in the human body. Now you will study the mechanism of respiration in humans.

What is respiration? How respiration occurs?

Let's discuss the whole process.

"Respiration is a biochemical process during which simple carbohydrates like glucose are broken down to release energy."

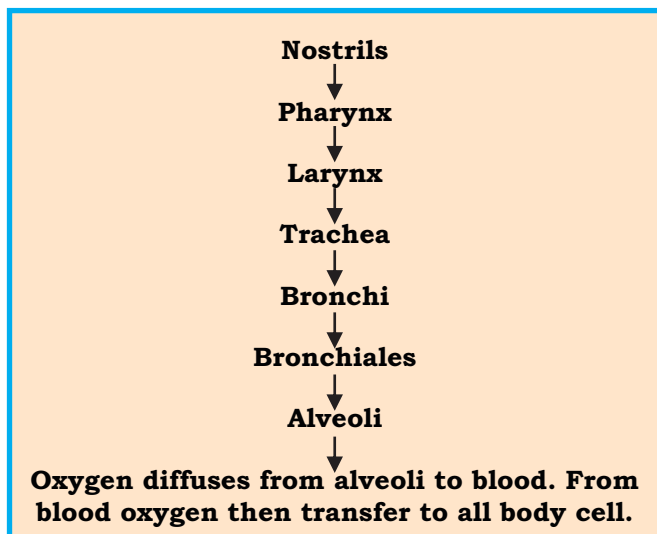
Every living organism needs oxygen and food for respiration. Food is converted into glucose that comes from the digestive system. We obtain oxygen from

INVESTIGATE

Respiration is an involuntary process. Justify this statement with scientific reasons.

our respiratory system. Then our circulatory system transport oxygen and food to the cell, where glucose combines with oxygen to release energy. In this process carbon dioxide and water are given off as waste products.

The whole process of respiration can be represented by word equation:

Glucose + Oxygen ⟹ Carbon dioxide + Water + Energy

DO YOU KNOW?

How oxygen enters inside your body?

We get oxygen through respiratory system. The flow chart below shows the pathway of oxygen within the respiratory system:

Figure 1.6
Respiratory system.

Respiration involves two processes

- Breathing
- Gaseous exchange

> **EXPLORING RESPIRATION**
> ***How do divers breathe under water as they have lungs not gills?***

What is breathing?

Can you stay alive without food or water for about one day? The expected answer is "yes we can". Can you stay alive without breathing even for a short period of time? Your answer should be "no we cannot".

We breathe through our respiratory system. As you observed in figure 1.7, the main organs of respiratory system through which oxygen enters the body. In order to make breathing possible the function of following parts is very important.

- Ribcage, collection of bones that protect the delicate lungs.
- Diaphragm, a muscular sheet.
- Thoracic cavity or chest cavity, protects respiratory system.

Breathing is a physical process in which oxygen is taken inside the body and carbon dioxide is given out from the body.

> **INVESTIGATE**
> Find out the. process of breathing while coughing and sneezing.

Breathing requires two processes

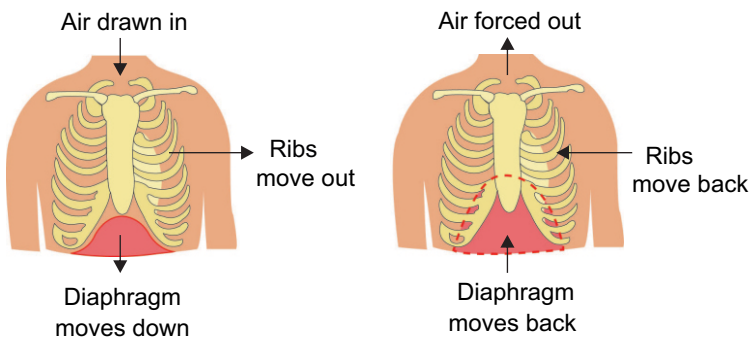
- ➢ The taking in of oxygen is called inhalation.
- ➢ The giving out of carbon dioxide is called exhalation.

When we breathe in (inhalation), diaphragm flattens, cause the ribcage to move out thus enlarges chest cavity.	When we breathe out (exhalation), diaphragm curves upwards, cause the ribcage to move back thus decreasing the size of chest cavity.

Figure 1.7 Illustrates the process of breathing.

What is gaseous exchange?

With the action of diaphragm, ribcage and thoracic cavity, oxygen from atmosphere comes inside the alveoli (lungs). How does oxygen from the alveoli diffuse in the blood (capillaries)? How does carbon dioxide from the blood diffuse inside the alveoli?

"The exchange of gases between alveoli and blood capillaries is called gaseous exchange."

You have already studied the structure of alveoli.

Alveoli have a microscopic structure consisting of single cellular layer.

They are completely surrounded by blood capillaries. When oxygen enters inside the alveoli, the diffusion process occurs. The oxygen from alveoli (high level) diffuse in blood capillaries (low level). Whereas carbon dioxide from the blood capillaries (high level) diffuses in alveoli (low level).

When carbon dioxide reaches the alveoli, it moves towards bronchioles, bronchi, trachea, larynx, pharynx and finally leaves the body through nostrils. This is called exhalation as we discussed earlier. Blood transports oxygen to the cells where it reacts with food to give energy.

DO YOU KNOW?

Is it possible to respire without oxygen?

Small microorganisms like fungi and bacteria respire without oxygen. This process is called anaerobic respiration. If oxygen is used in the respiration process it is called aerobic respiration like humans.

Anaerobic respiration is used in the production of vinegar, cheese, bread, etc.

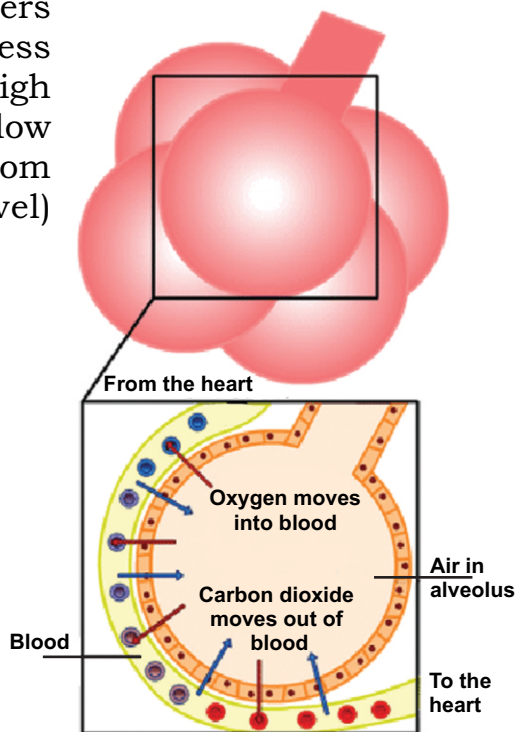



Figure 1.8 Gaseous exchange between alveoli and blood capillaries

INVESTIGATE

Record your breathing rate while you are watching TV and after doing two minutes exercise.

ACTIVITY 1.4 To demonstrate the process of breathing.

What I need:

- Plastic bottle.
- Cutter.
- 3 balloons.
- Cork.
- 2 Straws.

Figure 1.9
Experiment shows breathing process

What to do:

1. Take a plastic bottle, cut into half and use the upper-half of the bottle.
2. Put a rubber sheet (made by a balloon) at wide open part of bottle and seal it.
3. Put a cork at the mouth of bottle.
4. Make a hole to insert straw in it.
5. Fit a balloon at one end of straw which is inside the bottle.
   a) What happens when the rubber sheet is pushed down and pushed up?
   b) Note your observations and explain the biological process which has been shown in this model.

What I observed:

INVESTIGATE
Find out different ways of breathing process and gaseous exchange in animals?

What I concluded:

ACTIVITY 1.5 Lime water test:
To find out whether carbon dioxide is given off during respiration.

What I need:

- Test tube.
- Lime water.
- Straw.

What to do:

1. Take a test tube containing lime water.
2. With the help of the straw forcefully blow the expired air, inside the test tube.
3. Put a cork at the mouth of test tube.
4. Shake the test tube containing your expired air.

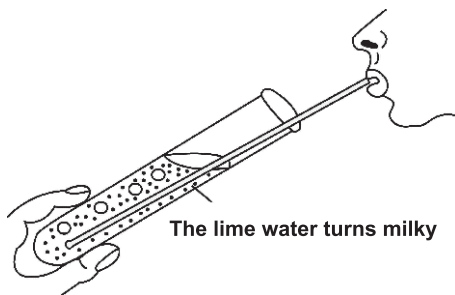



Figure 1.10 Carbon dioxide is exhaled during respiration

What I observed:

Activity questions:

1. Does the colour of the lime water change?
2. Why the lime water only gives that colour?

What I concluded:

Teacher Note: The teacher needs to arrange the apparatus for experiments. Also allow the students to perform the experiments in the presence of the teacher in the class.

Differences between Breathing and Burning Process

Do breathing (respiration) and burning differ from each other? Do you know breathing provides oxygen to the burning process to burn the food? Let's discuss more differences between them in the class.

Table 1.4 summaries the differences between breathing and burning process.

Breathing	Burning Process
It is a physical process as it forces air into and out of the lungs.	It is a chemical process as it burns food in the presences of oxygen.
It occurs in the respiratory system.	It takes place in all living cells.
It requires energy.	It releases energy.
Enzymes are not involved.	Various enzymes are required.

RESPIRATORY DISORDERS

- ✓ Identify the common diseases of respiratory system and discuss their causes and preventive measures.

Some common disorders of respiratory tract are cough, common cold, asthma, tuberculosis, pneumonia, and lung cancer. Here we discuss common cold, tuberculosis and asthma.

DO YOU KNOW?

Preventive measures of respiratory disorders

We can prevent ourselves from these disorders by eating fresh fruits and vegetables. Do regular exercise. Properly clean yourselves. Live in a pollution free environment. Do proper vaccination. Do not smoke.

Cold:

The cold is a common disorder of the upper respiratory tract (nose and throat). The main cause of the cold is environmental pollution.

sore throat, cough, congestion, mild headache, sneezing, watery eyes, low grade fever, mild fatigue, etc. There is no cure for the cold. It can be relieved by symptomatic treatment such as taking over the counter medications (throat lozenges, throat sprays, cough drops and cough syrups). Gargling with salt water may help those with a sore throat.

Tuberculosis (T.B):

Tuberculosis is a disorder of lower respiratory system (lungs). It is an infectious bacterial disease caused by *Mycobacterium tuberculosis,* in which the lung is damaged resulting in cough and fever. It is transmitted from person to person via nasal secretion and sputum. The symptoms of the active T.B of the lungs are coughing, sometimes sputum with blood, chest pains, weakness, weight loss, fever and night sweats. T.B is treatable with proper medical attention. It is more common in poor people. Malnutrition and poor living conditions facilitate Mycobacterium to grow.

Asthma:

Asthma is a serious chronic disease of the respiratory airways. In asthma bronchial tubes are always inflamed (swelling). It is an inherited disease, which means it transfers from parents to their offspring. It is an allergic response against cold, humidity, pollution, etc. Patients usually suffer from shortness of breath. Other symptoms are chest tightness or pain, chronic coughing and wheezing (whistling sound). It is not easy to cure asthma, but symptoms can be controlled with effective medication. Use inhaler and keep it with you all the time. It is better for the asthma patients to avoid congested places.

Summary

Mouth starts carbohydrates digestion. Also break food into pieces by teeth.

Pharynx swallows food.

Oesophagus transports food

Liver produces bile to break fat molecules into small pieces.

Stomach starts protein digestion. HCl kills germs.

Gall bladder stores bile

Pancreas digests carbohydrates, fats and protein.

Small intestine completes the digestion of carbohydrates, fats and protein. It helps in absorption of food.

Large intestine absorbs water and minerals.

Anus egests faeces.

Rectum stores faeces.

If rhythmic action of digestive tract becomes slow cause constipation whereas it rhythmic action of digestive tract becomes fast cause diarrhea.

HUMAN RESPIRATORY SYSTEM

Review Exercises

1. Circle the best answer.

i) Which is secreted by the liver and stored in the gallbladder?

(a) Saliva (b) Gastric juice

(c) Bile (d) Pancreatic juice

ii) Where chemical digestion of proteins start?

(a) Mouth (b) Oesophagus

(c) Stomach (d) Small intestine

iii) Which line shows the correct order of alimentary canal?

(a) Mouth → Oesophagus → Small Intestine → Stomach

(b) Pharynx → Stomach → Pancreas → Liver

(c) Pharynx → Liver → Pancreas → Small Intestine

(d) Mouth → Oesophagus → Stomach → Small Intestine

iv) Which structure prevents the food from entering the larynx during swallowing?

(a) Pharynx (b) Oesophagus

(c) Epiglottis (d) Tongue

V) Which option correctly shows the difference between burning and breathing process?

	Burning Process	Breathing Process
(a)	It is a physical process as it forces air into and out of the lungs	It is a chemical process as it burns food in the presence of oxygen
(b)	It takes place in all living cells	It occurs in the respiratory system
(c)	It requires energy	It releases energy
(d)	Enzymes are not involved	Various enzymes are required

2. Explain why:

i) Liver and pancreas are not considered as the parts of alimentary canal.

ii) Fats are not digested in mouth and stomach.

iii) Absorption only occurs in small intestine.

iv) Breathing is a physical process.

v) Pollution causes respiratory disorders.

vi) Don't speak while eating food.

3. Give brief answer to the following questions:

i) What is mechanical digestion? Discuss the processes of mechanical digestion that takes place along the alimentary canal.

ii) Describe the process of chemical digestion of a piece of potato that has been fried in oil, as it passes through following organs. Support your answer with enzyme word equations.

(a) Mouth

(b) Stomach

(c) Small intestine

iii) What preventive measures should be taken to avoid respiratory disorders?

iv) Discuss the adaptation of alveoli for gaseous exchange process.

v) Draw a flow chart to show the digestion of food in the human alimentary canal.

4. (a) Draw a labelled diagram of alimentary canal. Also draw the correct position of pancreas and liver in the digestive system.

(b) Draw a labelled diagram of gaseous exchange process in human body.

PROJECT

Object:

To investigate the process of respiration in an animal (Cockroach).

What I need:

i) Two conical flasks tightly covered with rubber bung.

ii) One small animal like cockroach or snail.

iii) Formalin chemical.

What to do:

i) Take two conical flasks. Place a live cockroach or snail in one flask and a dead cockroach or snail, that has been soaked in formalin to prevent decay, in the other flask.

ii) Close the mouth of each flask with rubber bung and make sure that the apparatus is airtight.

iii) Leave the flasks for three hour.

iv) After three hour, introduce a small lighted candle into each flask.

v) After introducing the candle, close the mouth of the flask tightly.

vi) Note the time taken for the candle flame to go off.

Leave for a few hours

rubber bung
wire
conical flask
cockroach

Live cockroach

rubber bung
wire
conical flask
cockroach

Dead cockroach
(soaked in formalin to prevent decay)

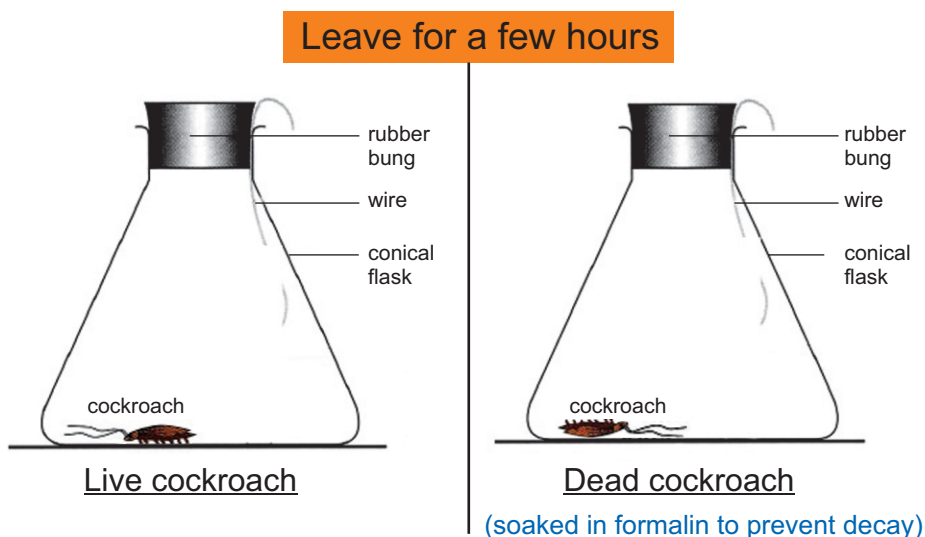



Figure Experiment demonstrates respiration in animal

What I observed:

Activity questions:

i) Give an explanation for your observation.

ii) Why we use dead animal in this experiment?

iii) Why we use airtight conical flasks?

What I concluded:

TRANSPORT SYSTEM IN HUMAN AND PLANTS

You have studied in previous chapter that the food we eat, gets digested, absorbed and distributed to all parts of the body. Similarly, you have also studied that we take in oxygen gas, in the breathing process, which also gets distributed to all body parts. Have you ever thought how the oxygen required by living things, move into their bodies and to the parts of the organisms where it is needed?

Do you ever wonder how waste product of the breathing process, 'carbon dioxide', is removed from our bodies?

In this Chapter you will learn about:

- Transport in Humans (Circulatory System, Heart and Blood Vessels)
- Common disorders (diabetes, heart problems and asthma)
- Transport in Plants
- Translocation in Plants

All the student will be able to:

- ✓ Explain the transport system in humans.
- ✓ Describe the structure and function of heart and blood vessels.
- ✓ Explain the working of circulatory system.
- ✓ Identify scientific developments that provide alternatives for dysfunctional body parts such as artificial tissues and organs; and their transplantation.
- ✓ Find out some disorders in human transport system can be affected by diet.
- ✓ Describe absorption of water in plants through roots.
- ✓ Explain how the structure of root, stem and leaves of a plant permit the movement of food, water and gases.

Figure 2.1 Human Transportation System

TRANSPORT EXPLORATION

Are diffusion and osmosis not sufficient enough to transport materials inside the multicellular organisms like humans? Why?

TRANSPORT IN HUMAN CIRCULATORY SYSTEM:

- ✓ Explain the transport system in humans.
- ✓ Describe the structure and function of heart and blood vessels.
- ✓ Explain the working of circulatory system.

Our body needs food and oxygen to produce energy and along with energy, waste materials are also produced in our body. How do all these materials move in our body? To help in movement of all these in the body, there is a need of transport system in human.

"The supply of food, water, oxygen and collection of waste materials such as carbon dioxide from our body is called transportation."

The transport system in humans is called the blood circulatory system.

(1) Blood Vessels:

The blood vessels transport blood to all parts of the body.

In humans there are three kinds of blood vessels; arteries, veins and capillaries. The blood leaves the heart in arteries and returns through veins. The blood vessels differ from each other in the structure of their walls. The main function of vessels is to transport blood throughout the body.

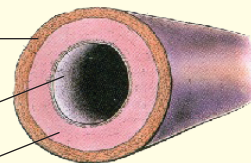
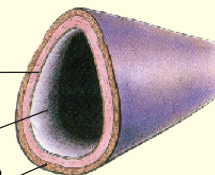
Arteries:

Arteries take blood away from the heart. The walls of arteries have a small lumen (internal space), with a thick

DO YOU KNOW?

What is circulatory system?.

This system involves the circulation of blood pumped out of a special organ called the heart through thousands of tubes called blood vessels and transporting fluid, blood.

BLOOD VESSELS

Do you find any difference in structural characteristics among these blood vessels?

A capillary

Very small lumen

Wall made of a single layer of cell

TRANSPORT EXPLORATION

Why is arterial diameter less than vein?

elastic and muscular structure, which can with stand the high pressure of the blood being pumped directly from the heart. The large arteries have greater proportion of elastic tissue which allows these vessels to hold up the high pressure caused by heart. While the smaller vessels called arteriole have less elastic tissue and more muscle fibres.

When these muscle fibres of the arteries contract, they make the passage in arteries smaller and restrict the flow of blood.

Arteries divide into very tiny blood vessels called capillaries.

Capillaries:

Capillaries are very tiny, microscopic and thin-walled vessels.

The thin walls of capillaries allow the exchange of oxygen, water, and nutrients from blood to cells. This also allows waste products from cells to pass into the capillaries. The walls of capillaries consist of single layer of cells which cause rapid diffusion of materials between cells and blood.

The capillaries gradually join up with one another to form veins.

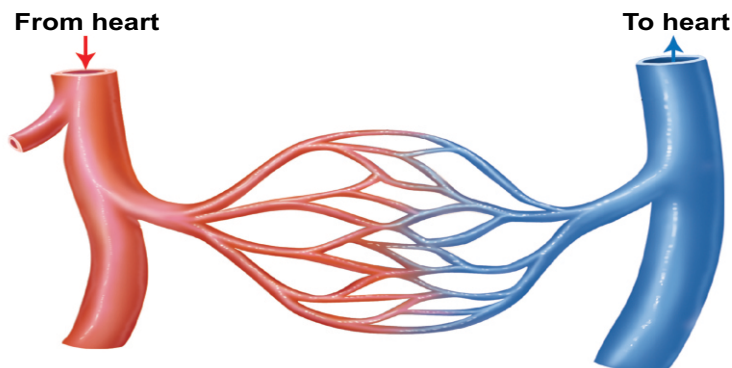
Veins:

All veins except pulmonary vein takes deoxygenated blood with less food and more carbon dioxide towards the heart. The walls of veins have larger lumen (internal space). They have thin wall, little elastic tissues and muscles that exert a lower pressure.

DO YOU KNOW?

All veins transport de-oxygenated blood to the heart except pulmonary vein carrying oxygenated blood.

Can you locate artery, capillaries and vein in figure 2.2?

Figure 2.2 Capillaries connect arteries to veins

INVESTIGATE

Can you guess the name of the structure which prevents the back flow of blood? This structure is normally present in veins.

(2) Heart:

Have you ever thought how the blood inside the blood vessels moves throughout the body? Which organ of the body forcefully pumps the blood in order to achieve maximum transportation? The heart is a hollow, cone-shaped and muscular organ; located between the lungs and behind the sternum (breastbone).

Two-thirds of the heart is located to the left of the midline of the body and one-third is to the right. The main purpose of the heart is to pump blood around the body.

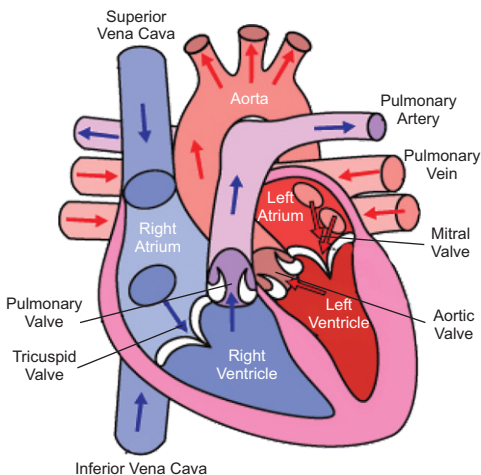



Figure 2.3 Human Heart

TRANSPORT EXPLORATION

Find out the name of arteries used to measure blood pressure and pulse?

DO YOU KNOW?

What is blood?

Have you ever thought how the transportation of materials is possible within the system? This job can only be performed by transporting fluid, blood. Before discussing the heart, it is very important to explore the main features of blood:

- Our body contains four to five litres of blood.
- Blood is red in colour, both in arteries and veins but only in figures blood is shown with blue colour in veins to differentiate flow of oxygenated (rich in oxygen)and de-oxygenated blood(rich in carbon dioxide) in arteries and veins respectively.
- Blood is used to transport various substances like digested food, gases, chemicals and waste products from one part of the body to another by flowing continuously around the body.
- The heart is enclosed in a double membrane-sac called as pericardium.

Blood Pressure:

Blood pressure is the pressure of blood exerted in the walls of the blood vessels. It is measured by sphygmomanometer. The normal value of human blood pressure is 120/80 mm Hg.

Pulse:

Pulse is the rhythmic contraction and relaxation of arteries. Normally it is 72 times pulse per minute.

The heart is divided into four chambers separated by right and left sections by a septum (partition wall). The septum keeps blood separated from each of the side. The right side of the heart receives de-oxygenated blood from all parts of the body and pumps the blood towards the lungs whereas the left side of the heart receives oxygenated blood from the lungs and pumps the blood to all body parts.

DO YOU KNOW?

Do you know coronary artery emerges from the beginning of the aorta, near the top of the heart; supplies blood to the heart muscles for its proper functioning.

The two smaller upper chambers with thin walls receive blood through veins are called atria. The two lower chambers with thick walls receive blood through atria are called ventricles.

TRANSPORT EXPLORATION

Ventricles have thick muscular walled than atria. Why?

Right atrium receives de-oxygenated blood from the superior vena cava (collects blood from upper parts of the body) and inferior vena cava (collects blood from lower parts of the body). Left atrium receives oxygenated blood from lungs through pulmonary vein.

Have you ever thought what would happen when atria contracts?

Does blood flow back from the ventricles into the atria?

Blood never flows back towards atria because of valves. Four sets of valves are found in the human heart.Two valves are present between atria and ventricles, whereas the other two valves lie between ventricles and arteries.

When both atria contract then blood moves to the right and left ventricles through tricuspid and bicuspid (mitral) valves respectively.

INVESTIGATE

At rest our heart beats about 70 to 75 times per minute. What would happen to our heart beats when we exercise?

Teacher Note: The teacher should show the model of human circulatory system. Also ask students question related to main components of system during observation. Teacher should also help students to correctly identify the location of heart and blood vessels, and draw the picture of the system in their notebooks.

When ventricles contract, then blood moves to the right pulmonary artery and left aorta through pulmonary and aortic valves respectively. Pulmonary artery takes the de-oxygenated blood towards lungs for purification, whereas aorta transport oxygenated blood to all parts of body. Figure 2.5 shows major steps involve in the circulation of blood with in the heart.

Circulation of Blood:

Circulation of blood starts from the right side of the heart. Heart pumps blood out of it along an artery to the lungs. Lungs purify the blood by diffusing oxygen from the inhaled air and release carbon dioxide in the exhaled air.

Through pulmonary vein' blood returns to the heart. (Fig:2.4)

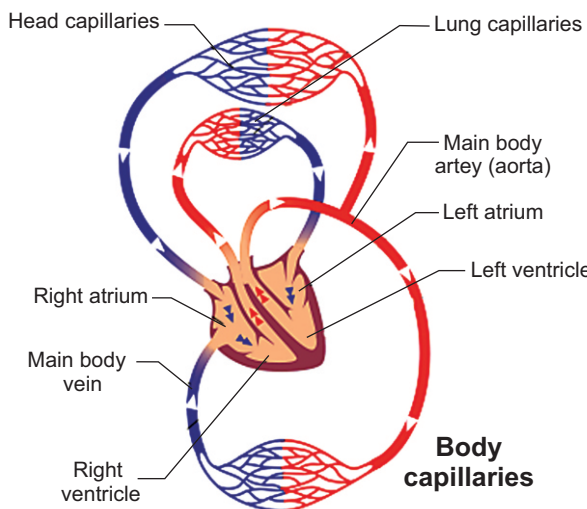
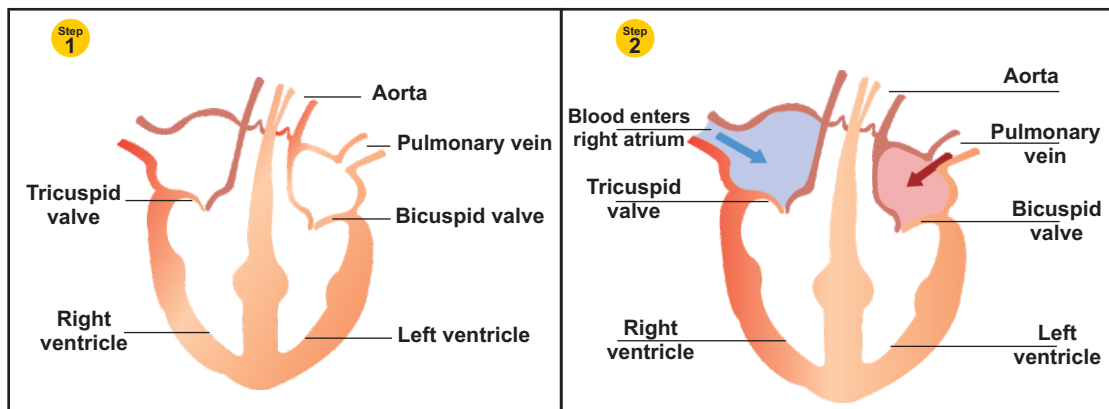



Figure 2.4 Circulation of blood in human

With the help of the pumping action of the heart, blood now enters in an aorta which transports blood to all body parts. Near cells, arteries spilt into smaller blood vessels called capillaries. In capillaries exchange of gases, digested food, minerals and waste products between cells and blood occur. The oxygen from the blood diffuses into the cells and carbon dioxide produced after respiration, diffuses from the cells into the blood. Hence in capillaries oxygenated blood changes into de-oxygenated blood. The capillaries join together to form veins carrying de-oxygenated blood, back to the right side of the heart.

Teacher Note: The teacher should show the video/ chart of human circulatory system. Also ask students questions related to role of blood vessels and heart in blood circulation. Teacher should help students to make a model of human circulatory system and present it in front of the class.

Following figures show circulation of blood within the heart.

Right atrium receives blood from the body parts through Vena cava and left atrium from the lung through pulmonary vein

Four chambers of heart

Step 3

Aorta
Pulmonary vein
Tricuspid valve
Bicuspid valve
Blood enters right atrium
Right ventricle
Left ventricle

Blood flows from left atrium to left ventricle through bicuspid valve

Step 4

Aorta
Pulmonary vein
Tricuspid valve
Bicuspid valve
Right ventricle
Left ventricle

Blood flows from right atrium to right ventricle through tricuspid valve

Step 5

Blood pumped to lungs
Aorta
Pulmonary vein
Tricuspid valve
Bicuspid valve
Right ventricle contracts
Right ventricle
Left ventricle

Blood flows from right ventricle to pulmonary artery through pulmonary valve, Pulmonary artery takes the blood towards lungs.

Step 6

Aorta
Pulmonary vein
Tricuspid valve
Bicuspid valve
Left ventricle contracts
Right ventricle
Left ventricle

Blood flows from left ventricle to aorta through aortic valve. Aorta transports blood to all body parts.

Figure 2.5 Circulation of blood within the heart

Activity 2.1: To investigate the effect of physical exercise on pulse rate.

What I need:

- Stop watch

What to do:

Figure 2.6 Checking pulse

- Hold one of your hands out with the palm facing upwards and the elbow slightly bent.
- Place your index and middle fingers on the inside of your wrist, just below the base of your thumb, as shown in figure 2.6.
- Press the two fingers lightly on your skin until you feel your pulse.
- If you feel nothing, either press harder or search with your fingers for the artery.
- Use stop watch to note down the time.
- Count the number of pulses for one minute.
- Now go outside the classroom and run for 2 to 3 minutes.
- Come back to your classroom and note down your pulse rate as per the previous method.

What I observed:

Activity Questions:

1. Were you able to feel your pulse on wrist?
2. Did you note time properly?
3. What was the pulse count in a minute?
4. What was the pulse count after fast walk or running?
5. Did you feel any difference in these two pulse rates? Why?

What I concluded:

Teacher Note: Teacher should help students to feel their pulse and let them to note down the time for a minute then send them outside the classroom for fast walk or running.

DISORDERS IN HUMAN TRANSPORT SYSTEM AFFECTED BY DIET

✓ Find out some disorders in human transport system that can be affected by diet.

Diet quality is strongly related to the diseases of circulatory system (cardiovascular system) in humans. It involves the heart and blood vessels. There are different heart diseases such as angina, heart attack, hypertension and hypotension.

People taking high quantity of fat, salt and low quantity of fruits, vegetables, whole grain and fish can have more risk of cardiovascular diseases. Besides this, the amount of salt consumed is also important to raise the risk of blood pressure and other cardiovascular diseases. Frequent intake of fast foods, processed foods and meat that are high in fats and sugars, promote obesity and may increase cardiovascular risk.

DO YOU KNOW?

❖ Hypertension may also cause brain stroke and haemorrhage.

❖ To avoid hypertension, it is important to take following preventive measures:

- Do not become over weight.
- Do not smoke.
- Avoid stress and tension.
- Avoid high cholesterol food.

Hypertension and Hypotension:

Hypertension is also known as high blood pressure. It is a chronic medical condition in which the blood pressure in the arteries is persistently increased. Blood pressure is expressed by two measurements; maximum and minimum pressures. Normal resting blood pressure in an adult is approximately 120/80 mm Hg.

If the blood pressure is below the normal, the condition is Hypotension or low blood pressure. Usually people do not consider it as disorder but this condition can also cause havocs. As most of the symptoms are common in both the conditions of blood pressure, so it is advised to check the blood pressure before having any medicine.

Angina:

Angina is chest pain that occurs if an area of heart muscle does not get enough oxygen-rich blood. It is a symptom of coronary heart disease.

Heart Attack:

Heart attack is a condition in which narrowing of arteries occur due to the deposition of high level of fatty acids (cholesterol) in arterial walls which increases the blood pressure. These arteries supply oxygen-rich blood to heart.

Due to accumulation, blood flow through a coronary artery gets mostly blocked. If blood flow isn't restored quickly, the section of heart muscle begins to die.

The symptoms of a heart attack can vary from person to person. Some of the most common symptoms of a heart attack are:

- Chest pain or discomfort.
- Upper body discomfort.
- Shortness of breath.
- Breaking out in a cold sweat.
- Feeling unusually tired for no reason, sometimes for days.
- Nausea and vomiting.
- Light headaches.

DO YOU KNOW?

❖ Heart attack is scientifically known as myocardial infarction.

❖ Despite accumulation of cholesterol, there are many causes of heart attack. Some are as follows:

- Smoking
- Increased stress
- Lack of physical activity

❖ The function of heart may be corrected by the use of artificial pacemaker. Pacemaker maintains the normal contraction and relaxation of atria and ventricles.

Heart attack can be diagnosed by different tests such as electrocardiogram (ECG), blood test and echo-cardiography (generally called as echo test). Heart attack may not occur if you have healthy lifestyle and good relationship among your family members.

Diabetes:

Diabetes is the common disorder of endocrine hormones system. In diabetes, blood glucose (sugar) level is high. Diabetes causes excessive thrust and large amount of urine. In this condition body does not process food properly for use as energy. Diabetes can cause serious health issues, heart disease, kidney failure and blindness.

People with diabetes might have some of following symptoms:

- Frequent urination
- Excessive thrust
- Weight loss
- Extreme hunger
- Sudden vision change
- Feeling tiredness

Blood sugar level is maintained through insulin injections in diabetic patients. Adopting healthy daily practices and taking exercise is very helpfull in maintaining sugar level.

TRANSPLANTATION OF DYSFUNCTIONAL BODY PARTS

✓ Identify scientific developments that provide alternatives for dysfunctional body parts such as artificial tissues and organs; and their transplantation.

There are developments in the medical field and many approaches have been adopted for treating the patients. One of the developments is formation of artificial tissues and organs and their transplantation.

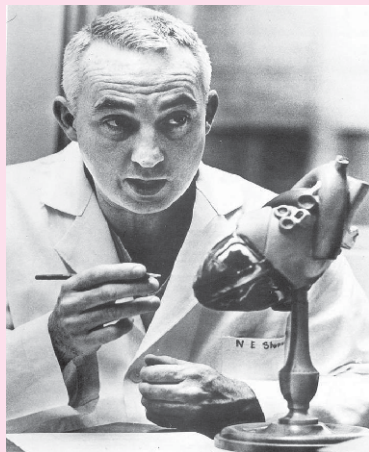
Do you know what is transplantation?

What are the benefits of transplantation to the patient?

"Transplantation is the replacement of a dysfunctional organ with a healthy one."

Heart transplant replaces the unhealthy patient's heart with a healthy donor heart. As transplantation is a very complicated process, patient requires regular check-ups by specialized cardiologist. However, what would happen if donors are not available? To avoid this problem artificial organs have been developed. An artificial heart maintains the patient's heart blood circulation.

DO YOU KNOW?

❖ Norman Shumway from United States is considered as the father of heart transplantation.

❖ National Heart Institute (United States) developed the artificial heart program in 1964, successfully implanted the artificial heart in 1969.

TRANSPORT IN PLANTS

- ✓ Describe absorption of water in plants through roots.
- ✓ Explain how the structure of root, stem and leaves of a plant permit the movement of food, water and gases.

Unscramble the given words

LMYXE

_ _ _ _ _ _ _ _ _

HINT: A tissue transports water in plants

MHPOLE

_ _ _ _ _ _ _ _ _

HINT: A tissue transports food in plants

Have you ever thought how transportation of materials occur in plants? Do you know some plants are small in size whereas others are very tall, like cone plants? Is the transportation in all plants either small or tall, similar? Do plants also need a pump to transport materials like animals which have heart to perform the job?

The two important processes in plants are photosynthesis and respiration that continuously require food and water.

Do plants efficiently transport food and water as per required?

The transport system in plants consists of xylem and phloem.

The xylem transports water and minerals from roots to the leaves via the stem while phloem transports sugar produced in the leaves to all parts of the plants.

TRANSPORT EXPLORATION

Explore the role of osmosis and diffusion in plant transportation.

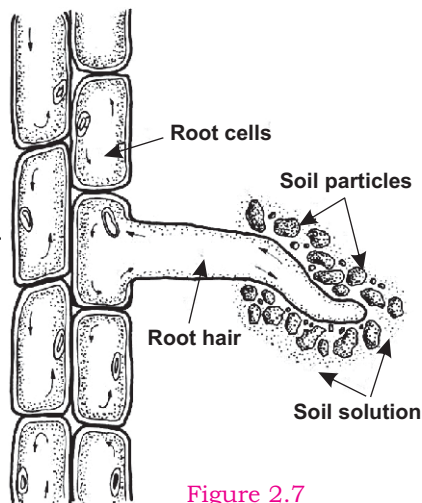



Figure 2.7

Structure of a root hair cell

Absorption of Water in Plants through Roots:

The minerals and dissolved gases available to plants for absorption are dissolved in the soil. The water enters the plant body through its roots. Roots are often extensive and grow rapidly in the soil.

In roots, water absorption takes place through the root hairs. Root hairs are tubular outgrowths of the outermost layer of root. There are thousands of tiny root hairs on each root. Being long, narrow and single cellular structure, the root hair increases the surface area for efficient absorption of water and mineral salts from the soil.

Water enters the root hair by osmosis in which the movement of water molecules from a region of higher concentration (soil) to a region of low concentration (root hairs) through a semi-permeable membrane (cell membrane) occurs.

Movement of water through roots, stem and leaves:

Through the process of osmosis and diffusion, the water and dissolved minerals and gases in the roots move from cell to cell towards the xylem. The xylem then carries them, to all parts of plant through root pressure and transpiration pull. Before discussing these forces let's explore the structure of xylem.

The xylem vessels form continuous channel from the roots through stem to the leaves. Water can move up through these channels. Xylem vessels are composed of dead cells, joined together to form long tubes. The strength in xylem vessel is provided by cellulose (carbohydrate).

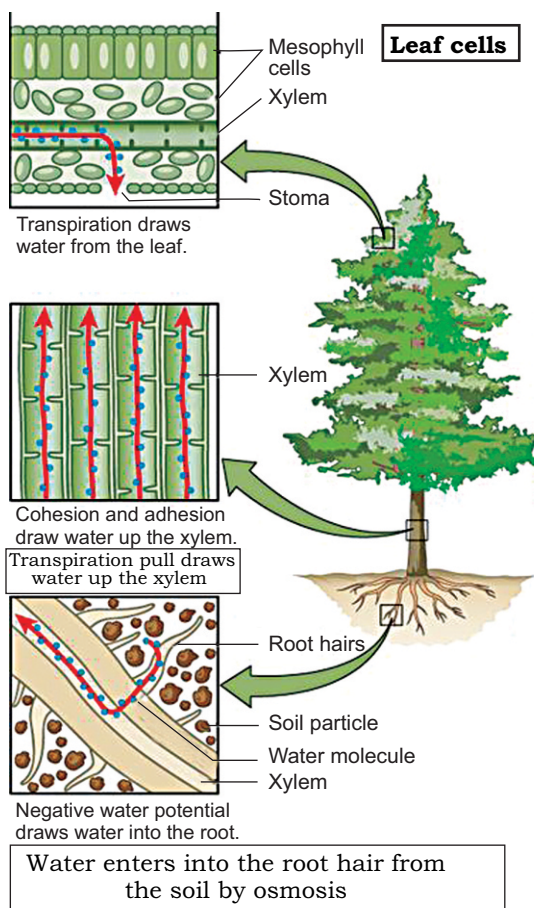



Figure 2.8 Illustrates the process of transpiration pull. (Transpiration of water in plant through xylem)

Root Pressure:

A force that is involved in the movement of water and dissolved minerals up in the xylem is called the root pressure. As a result of root pressure, the water with dissolved minerals rise to desired height in most plants.

Also it is not sufficient to bring water up to the leaves in tall plants.

How is water transported in tall plants?

Transpiration pull:

In tall plants transpiration pull transports the water in xylem. As we discussed in our previous class the process of transpiration.

> **TRANSPORT EXPLORATION**
> ***Transportation in xylem is unidirectional whereas in phloem is bidirectional. Why?***

"Transpiration is the evaporation of water from the aerial parts of the plant especially through leaves (stomata: small opening in leaf)."

Due to transpiration, transpiration pull occurs.

When leaf transpires the water inside the leaf cells drops.

This drop causes water to move from xylem (high water level) to leaf cells (low water level) through osmosis. The water then leaves the xylem thus generating the pulling force all the way to the root where water is pulled from the xylem.

Activity 2.2: How is water transported in plants?

What I need:

- Water Glasses (3-4)/Beakers.
- Water
- Food colour
- Leaves of balsam plants
- Sharp knife
- Cutting board

What to do:

- Fill half each of the water glass with water.
- Add few drops of red food colour in each of the water glasses.
- Stir the colour into the water.
- Cut the lower end of the balsam plant.
- Immediately put the roots of balsam plant in the water with colour.
- Leave it in the sun light.
- Observe them after 24 hours, and 48 hours.

Figure 2.9
Roots are immersed in ink

What I observed:

Activity Questions:

- Why did you cut the stem at the lower end?
- Why did you use food colour?
- Which part of plant stained red?

What I concluded:

TRANSLOCATION IN PLANTS

Translocation is the movement of food materials from leaves to other tissues throughout the plant. We have studied in class six that plants produce food (sucrose: carbohydrates) in their leaves by the process of photosynthesis, but other parts of the plant also require carbohydrates. For this reason, food is translocated from leaves to roots, stems, flowers and fruits. The tissue in which food moves, is the phloem.

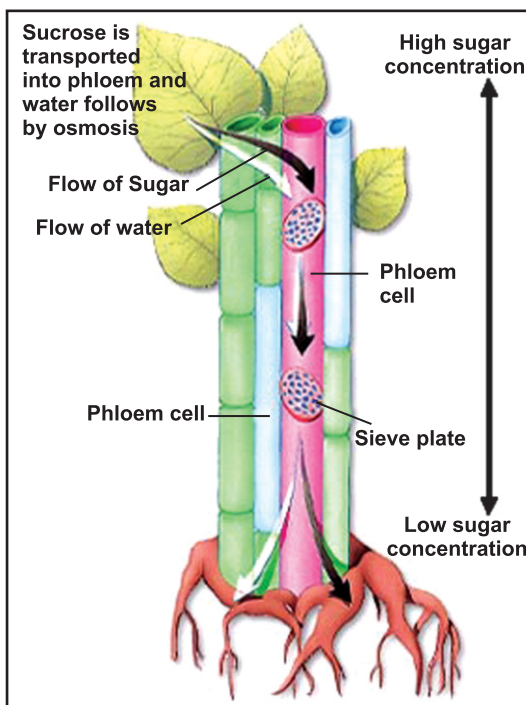
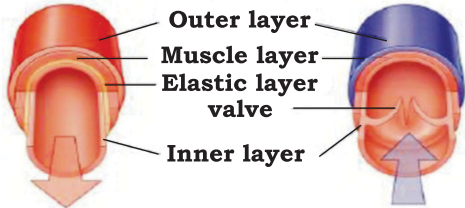
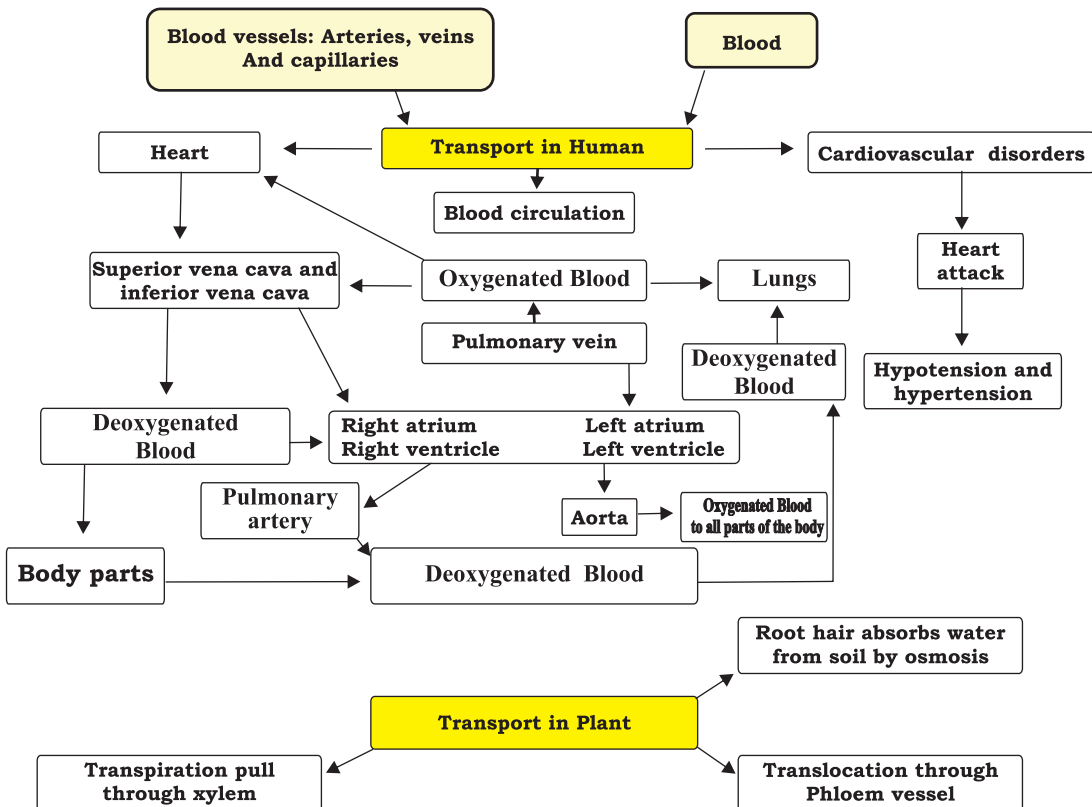



Figure 2.10 Translocation of food in plant through phloem

The phloem is long, continuous channel that extends through the roots and stem and reach into the leaves as veins. The food moves in phloem is composed of sugar dissolved in water, also called sap. All plants translocate carbohydrates. In many others, organic compounds are found such as proteins and hormones.

Summary

	Arteries	Veins
Direction of Blood Flow	From the heart to the body	Back to the heart
Oxygen Concentration	Carry oxygenated blood (except pulmonary artery)	Carry deoxygenated blood (except pulmonary veins)
Pressure	High	Low
	Outer layer, Muscle layer, Elastic layer, valve, Inner layer	
Structure	Thick outer walls, elastic and muscle layers	Thin outer walls, elastic and muscle layers
Location	Deeper in the body	Closer to the skin
Valves	No	Yes

Review Exercises

1. Match the statement of column 'A' with column 'B'.

Column A	Column B
i) Blood pressure also cause	(a) Xylem
ii) Absorbs water from the soil	(b) Aorta
iii) Occurs due to blockage in arteries	(c) Root hairs
iv) Supplies blood to all the parts of body	(d) Hypertension
v) Transports water in plants	(e) Heart attack

2. Fill in the blanks:
   i) De-oxygenated blood from all parts of the body is received by _________in heart.
   ii) Lungs receive de-oxygenated blood from heart through _______________.
   iii) The force applied by leaf cells, to drag water from the roots is known as _______.
   iv) The replacement of a dysfunctional organ with a healthy one is __________of the organs.
   v) Transportation of water takes place through continuous tubes in roots, stem and leaves are called as __________.

3. Explain why?
   i) Valves are present in veins.
   ii) Arteries contain oxygenated blood except pulmonary artery.
   iii) Narrowing of arteries cause heart attack.
   iv) The flow of xylem is unidirectional.
   v) Ventricles have thick muscular walls than atria.

4. Draw a labelled diagram of heart showing flow of blood in it.

5. Differentiate between the following:
   i) Arteries and veins
   ii) Atria and ventricles
   iii) Oxygenated and deoxygenated blood

PROJECT

Does phloem transport food (carbohydrates) to the different parts of the plant?

Materials required:

- Two potted plants.
- Sharp knife
- Water

Procedure:

1. Take two potted plants.
2. Mark one plant as A and second as B.
3. Remove a part of the stem tissue in the form of a ring or girdle from plant A.
4. Keep the plant B unchanged.
5. Keep both the plants in proper sunlight and water them.
6. Keep observing both the plants after 5 days, 10 days, 15 days, and 20 days or more period.
7. Note the changes over time.

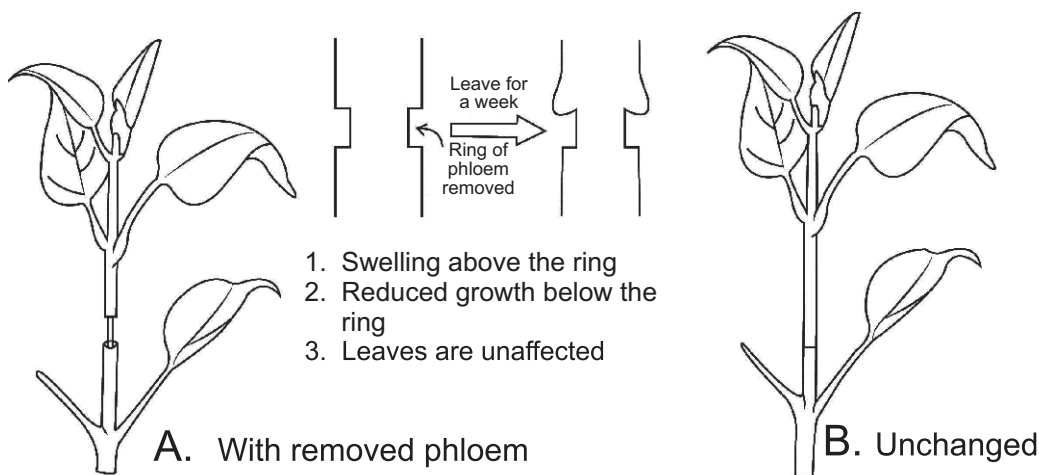



Figure Ringing experiment on phloem detection

Investigating Questions:

- What tissues were being removed along the removal of bark?
- What did you observe on the cut part of the stem?
- What does this experiment tell you about phloem?
- Why plant did not get wilt?
- What was your conclusion?

Explanation:

After few days it will be noticed that in plant A the portion of the stem immediately above the ring bulges (accumulation of food), while no such thing is observed in plant B which was taken as control (for comparison). This is due to the downward translocation taking place through phloem is affected in A due to its (phloem) removal, while no such thing happened in B as the phloem was not removed. This experiment suggests that phloem elements are involved in the translocation of food materials.

CHAPTER 3

REPRODUCTION IN PLANTS

You have already studied in the previous class about the life cycle of plant, which starts from the germination of small seed to a large plant. You have also observed plants and trees producing beautiful flowers and fruits. Do you know in flowering plants, flowers play an important role in reproduction? How do these plants start their reproduction process? Let us explore in this chapter what are the agents that are required by the plants to start their life cycle. We will also discuss the processes that are necessary for the plants to form seeds, fruits, pods and vegetables.

In this Chapter you will learn about:

- Pollination
- Kinds of pollination (self and cross pollination)
- Agents of pollination
- Kinds of reproduction in plants (Asexual and sexual reproduction)
- Process of fertilization
- Formation of fruit and seed

All the student will be able to:

- ✓ Define pollination.
- ✓ Compare self and cross pollination in plants.
- ✓ List various factors involved in cross pollination.
- ✓ Investigate plants which are cross pollinated.
- ✓ Differentiate between sexual and asexual reproduction.
- ✓ Describe fertilization.
- ✓ Describe seed and fruit formation.

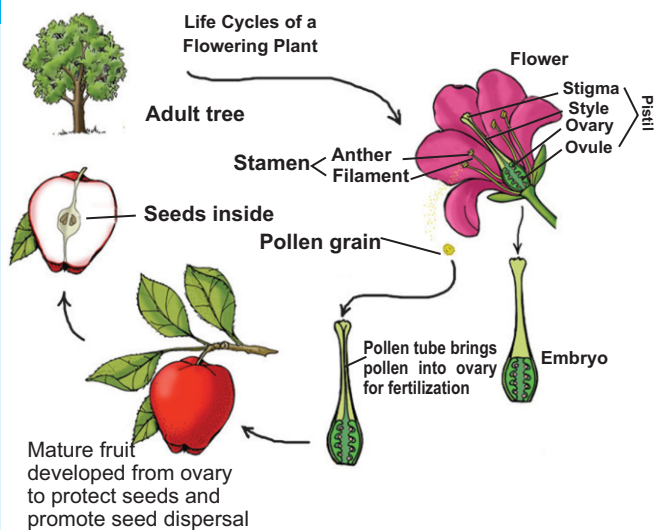



Figure 3.1 Life cycle of a flowering plant

REPRODUCTION EXPLORATION

Observe the following picture. Why do you think this bee is sitting over the flower? Does bee need food from the flower? How can bee help the flower?

POLLINATION

✓Define pollination.

REPRODUCTION EXPLORATION

Most flowers have more anther than pistils. Why is this so?

Have you ever thought what are the male and female reproductive parts of a flower? How flowers in plants transfer their reproductive structures to other plants for their life cycle? The process that is required by the plant to transfer their reproductive cells is called pollination.

"The transfer of pollen grains from anther of a flower to the stigma of the same or another flower is called pollination".

In order to understand the process of pollination, we need to explore the structure and functions of different parts of a flower.

INVESTIGATE

Can you guess the name of the reproductive structures of the flower? Are these structures present in all types of plants? Talk to your elder brother or sister, or with the help of the internet explore how these structures are helpful in reproduction?

Activity 3.1: Exploring structure and function of a flower.

What I need:

- Flowers (one for each group, according to class size teacher will decide the number of students in one group).
- Magnifying glass (hand lens).
- Blade for cutting the longitudinal section of flower.
- Cutting board or piece of wood for cutting the flower by placing on it.
- Pen and coloured pencils for drawing and labelling.

Figure 3.2 Structure of a flower

REPRODUCTION EXPLORATION

Do all flowering plants have both male and female parts in their flower?

What to do:

1. Place the flower on cutting board or piece of wood then cut it longitudinally with a sharp blade.
2. At the centre of the flower, there are the stamen and pistil. If you cannot see these parts, tear off the sepals and petals.
3. Locate different parts of a flower.
4. Write location and function of each part in the table given below. Also illustrates these parts.

What I observed:

Location and function of Parts of Flower

Flower part	Name of whorl	Location and function	Draw parts of a flower
Pedicel			
Receptacle			
Sepals			
Petals			
Stamen/Androecium/ Male reproductive part			
Anther			
Pistil/ Gynoecium/ Female reproductive part			
Ovary			

Activity Questions:

1. In your opinion, which part of the flower helps in the process of pollination?
2. Are sepals and petals not involved in reproduction?
3. Mostly the colourful flowers have long stigma. Why?

What I concluded:

Teacher Note: : Teacher will bring a China Rose/Hibiscus flower to the class and let students observe the different parts of a flower. Teacher guide students while dissecting flower. During dissection discuss the process of pollination.

Figure 3.2 illustrates how reproductive parts of a flower participate in pollination. Androecium (consists of stamens) is considered as male reproductive part because it produces male sex cells called pollens in the anther. Gynoecium (consists of pistil) is considered as female reproductive part because it produces female sex cells called egg in ovary. Both reproductive parts play very important role in pollination. Pollination is very important as it leads to the creation of new seeds that grow into new plants.

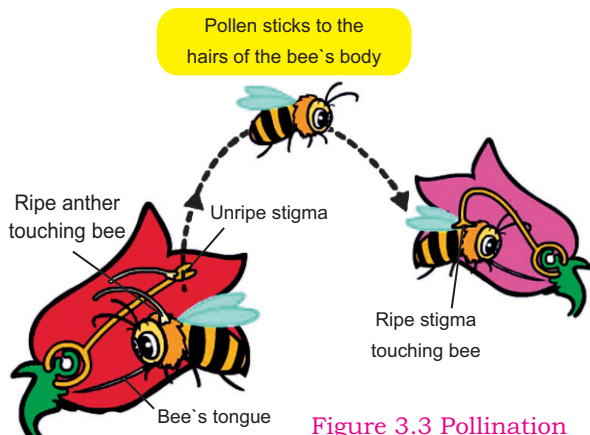



Figure 3.3 Pollination

REPRODUCTION EXPLORATION

Are petals involved in pollination? How do flowers with bright coloured petals perform more pollination than dull coloured petals?

Anther of stamen produces pollen, when these pollens get mature called the pollen grains, they cause anther to burst and releases pollens in atmosphere. These pollen grains now attach to the large sized and sticky stigma. On stigma pollens are converted into male sex cells called sperms. Have you ever thought what would happen if flower does not contain both reproductive parts? Do such flowers not perform pollination?

Activity 3.2: Look at figure 3.4 in which two different flowers are showing process of pollination. Can you categories what is A and B? Observe these pictures A and B carefully and write any three differences between them.

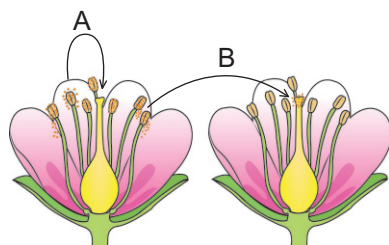



Figure 3.4

Self Pollination	Cross Pollination

KINDS OF POLLINATION

✓ Compare self and cross pollination in plants.

There are two types of pollination.

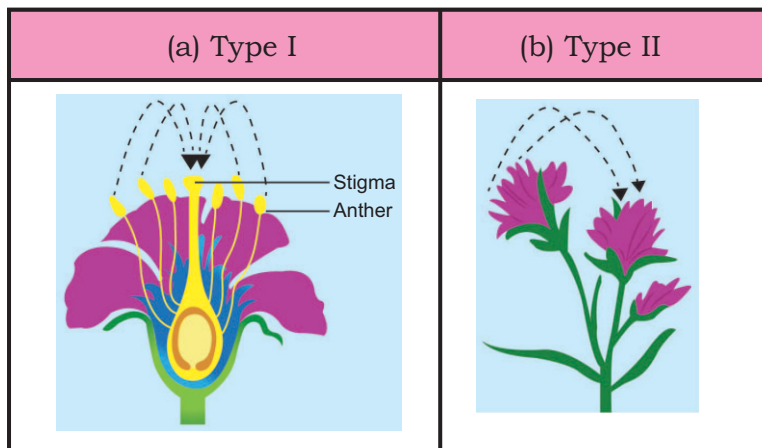
1. Self Pollination
2. Cross Pollination

1. Self Pollination:

In self pollination, mature pollen grains transfer from anther of one flower to the stigma of the same flower or another flower of the same plant. It means only one plant is involved in this process.

DO YOU KNOW?

- There are two types of flowers.
  - Complete flowers in which all four whorls are present i.e. sepals, petals, androecium and gynoecium.
  - Incomplete flower in which any one whorl is missing. Either these flowers contain androecium or gynoecium.
  - Complete flowers can perform both self and cross pollination whereas incomplete flowers can only perform cross pollination.

Figure 3.5 Two different methods of Self Pollination

INVESTIGATE

Investigate and make a list of at least five cross pollinated and five self pollinated plants. Find out which type of pollination is more beneficial for plants.

2. Cross Pollination:

In cross pollination mature pollen grains from anther of one flower are transferred to the stigma of flower on another plant of the same kind. Flowers of two plants of same kind are involved in this type of pollination and is called cross pollination.

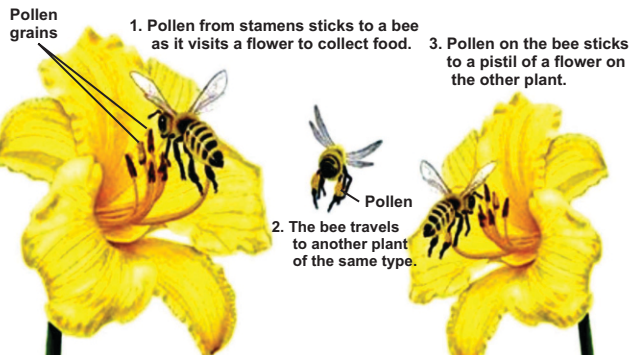



Figure 3.6 Cross pollination

Table 3.1 Comparison of self and cross pollination

S.No.	Self Pollination	Cross Pollination
1.	Only one plant is involved	Two or more than two plants of the same kind are involved
2.	Involves one flower	Involves two flowers
3.	The stigma and anther mature at the same time as one flower is usually involved.	The anther and stigma of the two flowers mature at the same time or different times
4.	Does not produce new variety of plant.	Produces new variety of plants.
5.	Does not require any agents to transfer pollen grains as one plant is involved.	Requires agents to transfer pollen grains as two plants are involved.

AGENTS OF POLLINATION

- ✓ List various factors involved in cross pollination.
- ✓ Investigate plants which are cross pollinated.

Have you ever thought how pollen grains are transferred from flower to flower for cross pollination? Do they require any agents to transfer the pollen grains? As you know plants cannot move from one place to another. Therefore cross pollination requires some agents to carry pollen grains from one plant to another plant. For instance, have you ever seen butterflies and honeybees sitting on flowers? These are the carriers of pollen grains from flower to another flower.

INVESTIGATE
Search for some interesting and informative facts about cross pollinated flowers.

The agents used for cross pollination are:

1. Wind
2. Water
3. Insects
4. Different types of animals.

1. Wind:

The wind blows and carries pollen grains from anther to stigma. These pollen grains are very small, light, smooth and some of them have wings or parachute like structures. These are produced in large quantity because a lot of them are being wasted. These flowers are called wind pollinated flowers. Flowers of cereal crops are mainly pollinated by wind.

2. Water:

Plants growing near ponds, river or streams are pollinated by water. Their pollen grains are light and flat so they can easily float on water. These flowers are called water pollinated flowers. Mostly coconut growing on river banks are pollinated by water.

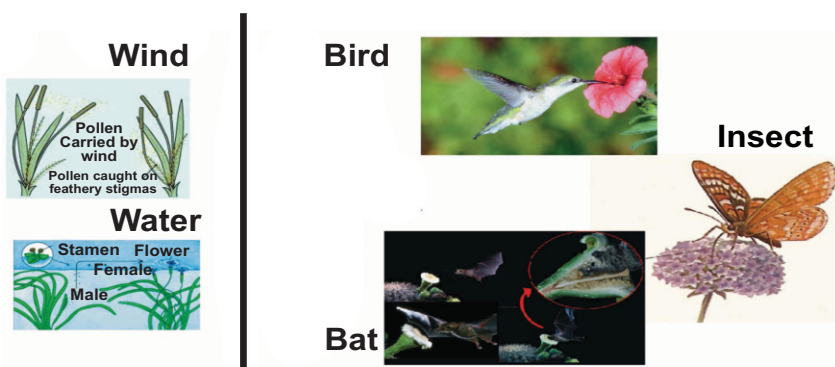



Figure 3.7 Agents of Cross pollination

3. Insects:

Plants that contain big, bright coloured and scented petal flowers are pollinated by insects, as these flowers secrete nectar. Usually ants, bees, butterflies, etc. sitting on the flowers for their nectar.

They help in cross pollination by sticking pollen grains with their legs and wings. Plants in garden are usually pollinated by insects as they have bright coloured petals and nectar cause an attraction for them.

4. Different types of Animals:

Animals like birds, bats, squirrels work as pollinating agent. Pollen grains stick with their feathers or fur and get transferred to another flower when they move from plant to plant. Fruit plants are mostly pollinated by animals as they eat them and throw their seed to distances.

Activity 3.3:

Sadia collected different types of flowers from a garden. She got confused that some flowers have large and wavy stamens, whereas some have small stamens. She also observed that the petals also varies in colours. Some petals have bright colours whereas others have white coloured petals. She took pictures of the two flowers. You should help Sadia to explore the type of flower she collected from the garden.

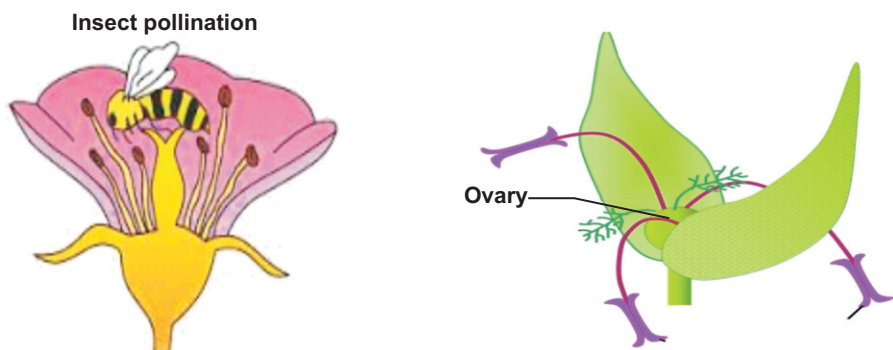



Figure 3.8 shows two different types of cross pollinated flowers.

- Label the stigma, anther and filament of these flowers.
- By what method do you think the flower is pollinated?
- How are the structures you have labelled adapted to the method of pollination you have mentioned above?

KINDS OF REPRODUCTION IN PLANTS

✓ Differentiate between sexual and asexual reproduction.

Reproduction is the process by which living organisms produce off-springs like themselves. Now we will have a look at how plants produce new plants. There are two methods of reproduction used by plants.

1. Sexual reproduction
2. Asexual reproduction

(1) Sexual Reproduction in Plants:

Flower of a plant contains male and female reproductive parts. We also discuss how these parts are involved in pollination and production of fruits.

"When sex cells are involved in the production of offsprings then this type of reproduction is called sexual reproduction. Flowers perform sexual reproduction."

Unscramble the given words

MEGASTE

_ _ _ _ _ _ _ _

HINT: a biological name of sex cells

VOMU

_ _ _ _ _ _ _ _

HINT: a biological name of egg cells

DO YOU KNOW?

❖ **Characteristics of male and female gametes:**

- Male gametes are small in size as compared to female gametes.
- Male gametes are produced in much larger numbers than female gametes.
- Male gametes either move by themselves or float towards female gametes.

Figure 3.9 Sexual reproduction

INVESTIGATE

Search for some interesting and informative facts about reproduction of flowers either sexually or asexually.

(2) Asexual Reproduction in plants:

Do you know the vegetative parts of a plant? Do these parts participate in reproduction? Can these parts produce off spring without sex cells? Vegetative parts of plant are roots, stem and leaves. They are called vegetative parts as these parts provide nutrients to plant. "*When sex cells are not involved in the production of offsprings then this type of reproduction is called asexual reproduction.*" Roots, stem and leaves also produce their off spring through asexual reproduction. As sex cells are not needed in asexual reproduction, there are no male and female reproductive structures involved in the reproduction process.

Differences between sexual and asexual reproductions:

Comparison of sexual and asexual reproduction

S.No.	Sexual reproduction	Asexual reproduction
1.	Usually two parents are involved	Only one parent is involved
2.	Sex cells are involved	No sex cells are involved
3.	Offspring identical to parents	Offspring are not identical to parents
4.	Does not produce large number of offspring	Rapid production of large number of offspring

PROCESS OF FERTILIZATION

✓ Describe fertilization.

Sexual reproduction not only involves transfer of male sex cells to female sex cell but also involves fusion of these sex cells. *The process in which fusion of male and female sex cells occur to develop a new plant is called fertilization.* Fertilization is an important process of sexual reproduction.

When pollen grains stick to the stigma of the flower, then these pollen grains converted into sperm sex cells and form pollen tube.

Teacher Note: Teacher will show video/chart of sexual and asexual reproduction of plants. Ask them to find out the main difference between these reproductions.

Through pollen tube sperm cells transfer from stigma to ovary. Ovary contains ovules in which egg sex cell is present. Pollen tube opens inside the ovary where sperms fuse with the egg cell and form zygote. Zygote on further development produces fruit and seed.

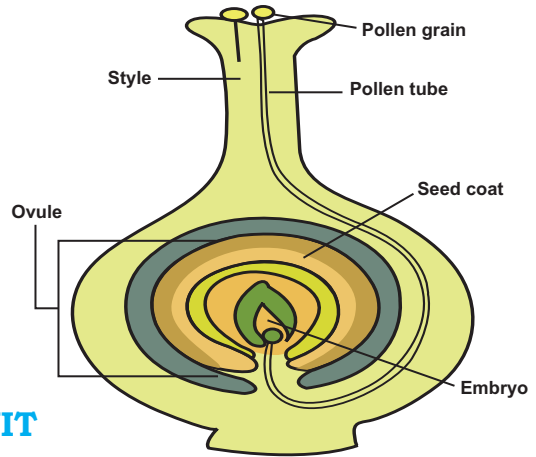



Figure 3.10 Process of fertilization in flowering plants

FORMATION OF SEED AND FRUIT

✓ Describe seed and fruit formation.

After fertilization and formation of zygote, the zygote undergoes repetitive cell division and develops into an embryo inside ovule. During this process the ovule enlarges and develops into seed. At the same time the ovary enlarges and successively develops into fruit. Ovary wall ripens to form the fruit wall. After fertilization, ovule form seeds and ovary forms fruit. As fruit matures, the petals dry up and fall off. Stigma, style and stamens usually wither and fall off.

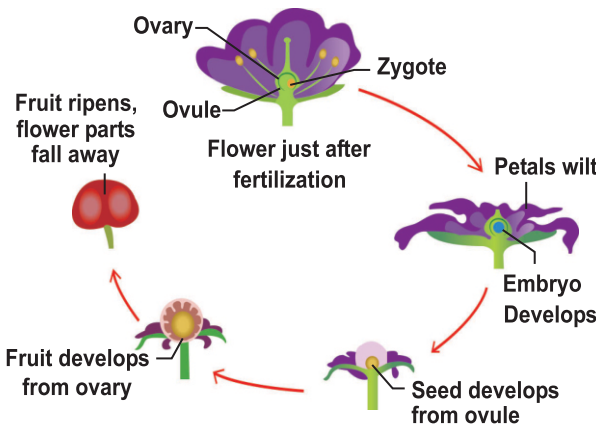



Figure 3.11 Formation of seed and fruit in flowering plants

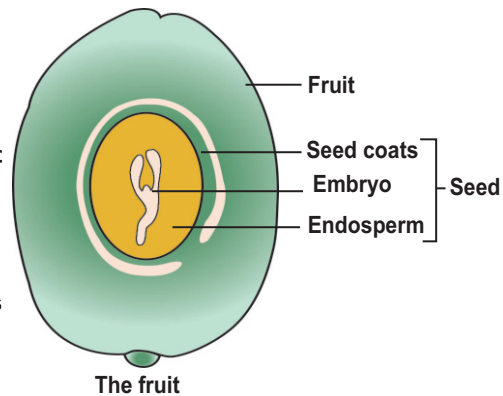



Figure 3.12 Structure of fruit

Summary

Reproduction
Asexual reproduction
Sex cells are not involved
Sexual reproduction
Sex cells are involved
3 steps of sexual reproduction
Pollination
Fertilization
Formation of seed and fruit
Self pollination
Cross pollination
Agents of cross pollination
Wind, water, insects and animals
Process of sexual reproduction
Male reproductive part
Female reproductive part
Anther produces pollen
ovary produces egg cells
Pollen grains transfer to stigma through pollination
Pollen grains mature and form sperms and pollen tube
Pollen tube penetrates inside ovary
Sperm reaches inside ovary
Fertilization occur
Ovule fertilized to form seed and ovary fertilized to form fruits

Review Exercises

1. Write answers of following questions.

i) How is reproduction important for living organisms?

ii) Differentiate between asexual and sexual reproduction.

iii) Give the structure of pollen grains which are pollinated by wind and water.

iv) With the help of flow chart discuss the steps involved in fertilization of flower.

v) Brightly coloured petals attract insect pollinators. How are flowers that do not have brightly coloured petals pollinated?

2. Encircle the most appropriate answer:

i) The process by which living organism increase their numbers is known as:

a) Digestion b) Respiration c) Reproduction

ii) The type of reproduction in which two parents of different sexes are involved:

a) Asexual reproduction b) Sexual reproduction c) Both

iii) Zygote forms after the fusion of different:

a) Embryo b) Gametes c) All the body cells

iv) Pollen grains are microscopic structure located in:

a) Anther b) Pistil c) Petal

3. Fill in the blanks:

i) Protective coverings on the outside of the flower are usually ___.

ii) The _____________ produces sperms in flowers.

iii) The wind, __________, insects and animals are the agents of cross pollination.

iv) The female reproductive part of the flower is called ________.

v) The sexual reproduction involves ___________ and egg cells.

4. Draw neat, clearly labelled diagrams to show the following processes.

i) Self pollination and cross pollination

ii) Formation of seed and fruit

ENVIRONMENT AND FEEDING RELATIONSHIPS

Earlier you have studied that there are three types of environment i.e. land, water and air. Grasslands, wetlands and forests are an example of terrestrial environments, whereas lakes, rivers and oceans belong to the aquatic environment. These environments have different characteristics and features by which they are recognized as well. They are the habitats of many living organisms. Have you ever thought, why all plants and animals are important to the environment? Why some organisms are abundant in a particular environment? How do organisms find the best place for them to live? Why survival of species at some places is easier than other places?

You have studied that the community of living organisms (biotic component) interacts with non-living environment for food, shelter and protection. The interaction of community with non -living environment (abiotic factor) in a particular area for survival is called **ecosystem**. Let us explore different types of ecosystem and interaction present in them.

In this Chapter you will learn about:

- Ecosystem
- Habitat
- Kinds of Habitat
- Biotic components and their relationship with food chains and food web

All the students will be able to:

- ✓ Explain the ecosystem
- ✓ Define the term habitat
- ✓ Compare the different kinds of habitats
- ✓ Investigate the various features that allow animals and plants to live in a particular habitat
- ✓ Identify the factors that cause daily and yearly changes in a habitat
- ✓ Explain how living things adapt to daily and yearly changes in their habitat
- ✓ Explain the ways in which living things respond to changes in daily environmental conditions such as light intensity, temperature and rainfall
- ✓ Explain why food chains always begin with a producer
- ✓ Illustrate the relationship between producers and consumers
- ✓ Describe two food chains in the environment around them
- ✓ Explain a food web

ECOSYSTEM

✓ Explain the Ecosystem.

Ecosystem is a place in water or at land where biotic component i.e. community interact with non-living environment. The community of biotic components such as plants, animals, and microorganisms and abiotic components (water, air, nutrients and solar energy) when interacts for survival in the environment make up an **ecosystem.** These fresh water, terrestrial or ocean **ecosystems** could be as large as the desert, forest and it can be as small as a pond or school garden. All those components that interact in an ecosystem are called factors. As we have studied earlier, there are of two types; Biotic and Abiotic factors.

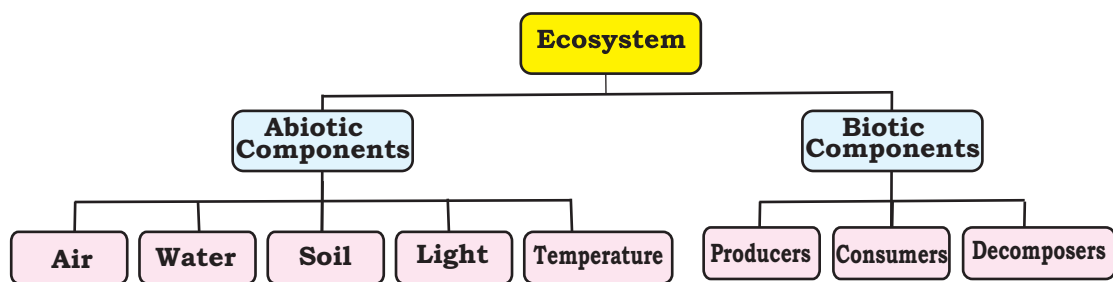



Figure: 4.1 Components of an ecosystem

When different organisms (biotic factors) interact with members of their own species as well as with the members of other species and with their physical environment (abiotic factor), they form an ecological system or ecosystem. This interaction may be for the sake of food, shelter, protection and reproduction. The biotic and abiotic components are very important for sustaining an environment.

Activity 4.1: Observe the ecosystem and make a list of biotic and abiotic components.

Pond ecosystem

Grassland ecosystem.

Pond Ecosystem	Grassland Ecosystem
....	....
....	....
....	....
....	....

The interactions between biotic and abiotic components in ecosystems help in maintaining the balance between these components and the environment. These interactions are responsible for obtaining the stability in the environment.

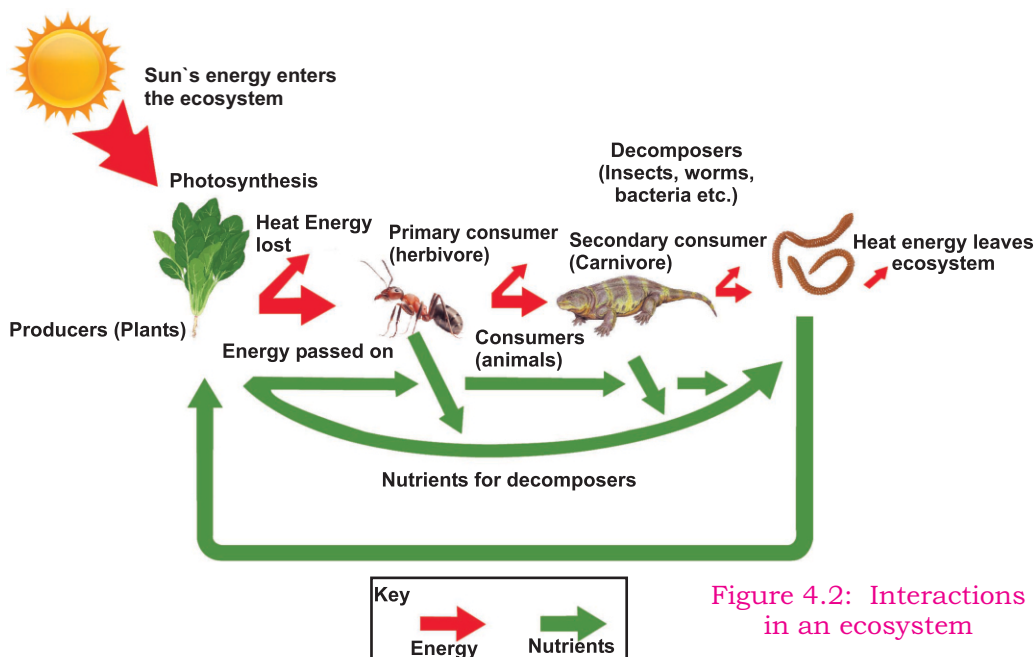



Figure 4.2: Interactions in an ecosystem

The deserts, seashore, mountains, rivers, oceans, grass lands and rainforests are some of the world's ecosystems. Earth itself is a huge ecosystem. Ecosystem can be defined in summarized form as:

Ecosystem = Habitat + Community of living things

The Earth has many different ecosystems, which vary in life forms, temperature, moisture, light, and other factors. Each of these ecosystems has distinct life forms living in it, which form complex communities of interdependent organisms.

HABITAT

✓ Define the term habitat.

A habitat is an ecological area or environment in which species of animals, plants and all types of organisms live. The term typically refers to the space in which the organism lives and where it can find food, shelter, protection and mates for reproduction. The habitat is a place of living which provides the organisms all requirements to survive. Habitat is not necessarily a geographic area; for example, for a parasite, the habitat is the body of its host where from it gets food and find suitable environment to live in. Habitat is made up of physical factors (abiotic) such as kind of soil, moisture in air, range of temperature, availability of light throughout the year and some biological (biotic) factors like availability of food.

Figure 4.3: Different habitats

KINDS OF HABITATS

✓ Compare the different kinds of habitats

According to its physical characteristics, there are two types of habitats:

(1) Aquatic and (2) Terrestrial Habitat

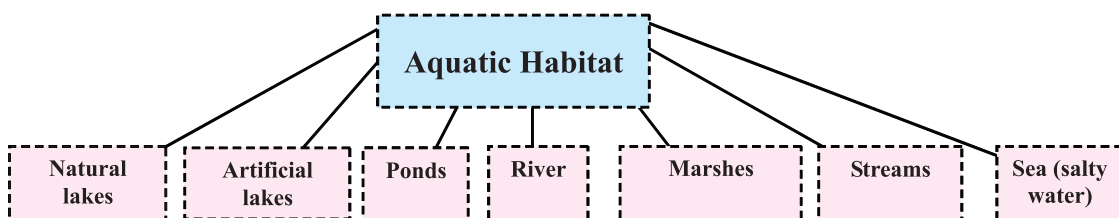
Aquatic Habitat:

The living organisms which live in aquatic environment surrounded by water, they get all the resources from the water in which they live. They develop their body organs to survive in this environment. The aquatic habitat also varies with the nature and physical state of water e.g:

Freshwater Habitat ⟹ Water Contain very low amount of salt

Marine water Habitat ⟹ Water Contain high amount of salt

Estuarine water Habitat ⟹ Area where river meet with sea.

The examples of fresh water and flowing water habitat are: rivers, streams, lakes, ponds and pools.

Rivers and Streams:

Rivers and streams refer to systems with rapid flowing waters that move in a unidirectional way. For several species rivers and streams, are safe places to live. Crustaceans like crayfish and crabs; and mollusks such as clams and limpets are commonly found in streams and rivers. Various mammals such as beavers, otters and river dolphins also inhabit rivers and streams ecosystems.

Figure 4.4 River Indus

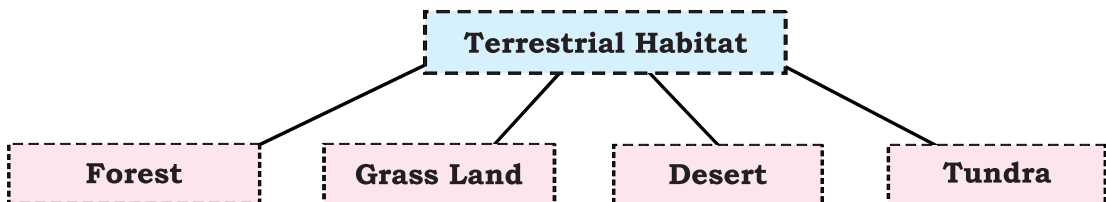
Figure 4.5 Clifton Beach

Lakes, ponds and pools:

Ecosystems of still waters such as lakes and ponds that have a community of biotic (living organisms) and abiotic (physical objects) interactions. Ponds and lakes have a diverse variety of organisms including algae, rooted and floating-leaved plants, invertebrates such as crabs, shrimps, crayfish, clams etc, amphibians such as frogs and salamanders; and reptiles like alligators and turtle.

Terrestrial Habitat:

Organisms living on land obtain their resources from soil, land and air. Factors which influence life on land are light, temperature, rain, availability of water etc. Following are the main types of terrestrial habitat.

Figure 4.6 Photographs of Terrestrial Habitat

Forest:

Forest is land where rainfall is high i.e 250 to 450 mm annually. It has many trees and combination of herbs, shurbs, plants, seedlings and several varieties of birds, mammals, insects, reptiles, amphibians and small creatures.

Grassland:

Habitat where rainfall is lower than forest so it does not support growth of trees. The condition in grassland grows i.e wheat, maize, long grasses which are the food source for grazing animals. The grassland further divided into two main types:

i) Temperate Grassland: Temperate grass and has a mild climate and four seasons. Soil of these grasslands is rich in humus.

ii) Tropical Grassland: Tropical grasslands are near the equator and the environment remains warm all around the year. Rainy and dry seasons are found here. Trees are abundant and soil is poor.

Desert:

Area where rain fall is very low resulting barren area where living condition is hostile for plants and animals. Largest dessert in Pakistan is Thar.

Figure 4.7 Desert

Tundra:

Area below ice caps which are very cold regions, it is difficult to live in these areas, only migratory animals can survive under favorable conditions i.e Antarctica. The organism like Polar Bear, Arctic Foxes, Snowy owl are the inhabitant of this biome.

Figure 4.8 Tundra

Activity: 4.2: Sorting Animals and Plants according to their Habitats:

What do I need:

List of animals and plants (given below in the box).

What to do:

Look at the habitats in the table below. Names of different plants and animals are given in the box below the table. Copy the table in your exercise book and write the name of each plant and animal in the correct column.

INVESTIGATE

- Which place is most suitable for growing coconut trees?
- Why pine trees grow in hilly areas?
- Why Mango trees cannot grow in Gilgit?
- Why polar bears are not found in Thar Desert?

Sea/Deep water	Forest/wood	Garden	Urban Town	Desert

Snail, flower, seaweed, camel, ladybird, squirrel, owl, deer, pegion, rat, oak tree, shark, earth worm, cactus.

ACTIVITY 4.3: Comparing the different kinds of Habitat: Group Activity (Poster Presentation) .

What I need:

Textbook, Internet/ old magazines and books

What to do:

- Read the text given in your textbook about different types of habitat.
- Search the internet /read books from the library/ magazines/old books to find out the qualities of each habitat.
- Visit different habitats (if possible).
- Based on readings and observations compare different kinds of habitat.
- Discuss with your teacher, classmates, senior classes and parents.
- If possible interview with an environmentalist.
- Present your findings to the whole class in the form of poster presentation.

DIFFERENT FEATURES THAT ALLOW ANIMALS AND PLANTS TO LIVE IN A PARTICULAR ENVIRONMENT

✓ Investigate the various features that allow animals and plants to live in a particular habitat.

Each kind of environment has different kinds of animals and plants habitat. Animals and plants develop many ways to survive in a particular environment. Palm trees grow near coastal areas and pines at high altitude.

Polar bear lives in cold area and lion in grassland because their requirements of life are present in these areas. If a particular type of need do not meet by a habitat, the living organisms will either migrate to better place or adopt themselves according to the habitat. For example human beings living in warm area produce black pigments in their skin to protect them from sunlight but the people living at high altitude do not produce black pigment in very high quantity so their complexion remains fair.

How organisms adapt to live in a particular habitat?

Group of organisms of a particular type live in a specific habitat called population. They have special features to survive in that habitat. Plants require sunlight, water and minerals from soil to prepare their food by the process of photosynthesis. In order to receive larger amount of light most of the plants adopted to produce broader leaves. If due to some geographical changes there is water scarcity the plant become unable to survive in this condition, therefore they develop some characteristics by which they reduce water loss for example: cactus plant adopted spines on its stem. Some animals like earth worm prefer to stay in the dark hence they burrow under the soil. This adjustment of living organisms in a particular environment for the usage of available resources is called adaptation.

Different factors, such as duration of light, temperature, availability of water, speed of wind, humidity in air, snow, salty water, minerals in soil, availability and nature of food, and protection from predators influence living organisms to modify their characteristics.

Activity 4.4: Name one organism in which you can find adaptation for each of the above mentioned factors.

Climate change is a change in average weather conditions. Climate change is caused by factors such as biotic processes, variations in solar radiation received by Earth, tectonic plates and volcanic eruptions. Certain human activities have also been identified as significant causes of recent climate change, often referred to as "global warming".

Heat received from the sun greatly influences the temperature of a place. Most of the living organisms are active at temperature in between $0^{\circ}C$ to $45^{\circ}C$. Organisms living at below $0^{\circ}C$ temperature have adopted the fur on their skins. Shedding leaves and hibernation (winter sleep under the mud) are two adaptive processes which have enabled plants and animals to survive under minimum temperature.

In some habitats due to scarcity of water animals and plants adapted to store water and reduce water loss. For example the cactus plant has spines instead of leaves to overcome the water loss. In animals, camels drink lot of water at one time to store it in their humps.

ENVIRONMENTAL FACTORS THAT CAUSE DAILY AND YEARLY CHANGES:

✓ Identify the factors that cause daily and yearly changes in a habitat.

As you know that environmental factors are not constant and keep on changing in different parts of a habitat, at different times of a day or at different times of the year. If you note the temperature of a place at different times of a day, you will find it different. Similarly, sun shines during the day so days are warm and bright.

DO YOU KNOW?

Habitat is not necessarily a geographic area e.g. for a parasite habitat is the body of its host where from it get food and found suitable environment to live

However at night when the sun does not shine on our part of the Earth it is dark and colder. Some animals are most active during the daytime. They are diurnal and some are most active during the night, they are nocturnal. Can you give some examples of diurnal and nocturnal animals found at the place where you live?

Seasonal or yearly changes in Environment living things adapt to daily and yearly changes:

There are four seasons in a year. In every season environmental factors change a lot. In summer, nights are short and days are long.

It is quite warm during the day but even after sun set it does not get very cold. In winter, days are short and nights are long. In Sindh it does not get very cold in the day and at night. However in Punjab, Khaybar Pakhtoon khwa and Balochistan it is comparatively cold. There may be frost and snow.

Natural disasters such as drought, floods, earthquakes also bring changes in environment. If there is no rain for a long time then this period is called drought. During drought most plants and animals found on land in lakes, ponds and streams will die. Some animals move to other places.

Flood is another disaster caused by heavy rains for longer time. During a flood many plants, animals and human beings die or move to another safer places. Lightning also cause fire in forest, which burn different animals and plants. It takes many years for a forest to grow back.

Earthquakes also bring changes in the environment. On October 08, 2005 and recently on October 26, 2015 a large spread area of Pakistan was damaged due to massive earthquakes.

Activity 4.5: Investigating a local ecosystem

What I need:

- Choose a local ecosystem to study.
- Pen/Pencil
- Exercise book

INVESTIGATE
Investigate a few organisms that live in a
1. Brightly lit environment
2. Shady environment
3. Dark environment

What to do:

Select an ecosystem near your school.

- Visit the selected ecosystem, observe and record observations in exercise book.
- Present observation and conclusions to the whole class.

What I observed:

Name of producer	Name of primary consumer	Name of secondary consumer	Name of tertiary consumer	Name of non living or abiotic factors

Write your observations in your exercise book. Consider the following questions for investigation.

Questions for discussion:

- What does these animals and plants eat?
- Does this place have more producers than the consumers?
- How many food chains are present in this ecosystem?
- Did you observe any decomposer?
- Draw a web of ecosystem make sure to include the sun.

What I Conclude:

____

____

____

Activity 4.6: Comparing environmental factors in day time and at night time.

What I need:

- Thermometer for measuring temperature.
- Anemometer for measuring the speed of wind.

What to do:

Place of observation:- ____________________ Date:__________

Environmental factor	Day time	Night time
Temperature in ^{0}C		
Light Intensity		
Wind Speed		

Which animals are found in day time and which are found at night?

What I Conclude:

____

____

____

In the above examples of ecosystem you can observe a particular environment in which particular types of living organisms live. For example you cannot find tall wooden trees in grasslands or in a pond you cannot find large whales or sharks you will find only small fishes and frogs.

How living things adapt to daily and yearly changes in their habitat?

Each kind (species) of living organisms is able to live in a particular habitat. Each has special features which help it to survive in that habitat. These special features are called adaptations. The adaptations help the organism to cope with the environmental factors in their habitat. We say that each specie is adapted to its habitat. Organisms that are not well adapted to their habitat may not survive. Examples of these adaptations are camouflage, migration, hibernation, estivation, body covering etc.

Camouflage:

Some animals have the property to change their colour according to their surrounding in order to hide from enemies for their survival.

Migration:

It is the relatively long distance movement of animals from one place to another, usually on seasonal basis. Usually birds, fish, reptiles etc migrate to protect themselves from extreme hot and extreme cold temperatures.

Hibernation:

It is a winter sleep that helps animals to save energy and survive in the winter without eating much.

Estivation:

When animals slow their activity in hot and dry summer months. During a period of Estivation, many reptiles go underground where it's cooler. Estivation is very similar to hibernation, when some mammals spend the winter moving very little and sleeping a lot, in order to save energy.

Body coverings:

It help animals to survive with environmental changes. For example scales are a type of body covering that fish and reptiles have. Fish are animals that live in water. Reptiles are cold-blooded animals. This means that they can not maintain their body temperature by themselves but we can maintain our temperature in variable temperature.

THE PHYSICAL ENVIRONMENT

✓ Explain the ways in which living things respond to changes in daily environmental conditions such as light intensity, temperature and rainfall.

The climate of a place is very important in the physical environment of a place. It determines the type of organisms living there. As the environment can never be best suited for every organism living in it, some organisms have adapted to their environment by developing certain features which enable them to live successfully in their environment. Following are the physical factors which make up the physical environment.

Light:

Plants use light energy from the sun to make their own food. Light intensity and quality affect photosynthesis. As other forms of energy depends directly or indirectly on green plants for food, they are also dependent on light for survival. Light also enables many living organisms to see, so that they can move about, find food and detect danger.

Some organisms such as earthworm prefer to stay in the dark. They have special features to live in a dark environment. Insects such as fireflies and deep sea fish produce their own light to illuminate their prey, confuse their predators and attract their mates. Visibility affect detection of prey.

Temperature:

The heat received from the Sun greatly influences the temperature of a place. Most organisms are active at temperatures between 0^{0}C and 45 ^{0}C. However, aquatic animals and marine plants can remain active at freezing temperature of around -1 ^{0}C. On the other hand certain invertebrates live in hot springs which have temperatures about 59^{0}C while some algae can grow in water having temperature of up to 80 ^{0}C.

A particular specie has a level of tolerance range within which it functions best. This is its optimal range for that factor within which it functions best, it may be broad or narrow depending on the species e.g. experiencing prolonged period of extremes of temperature that can result in heat stroke or hyperthermia. Some plants are shade loving while others require a high light intensity if they are to thrive.

Humidity:

Humidity affects water loss from plants and evaporation from animals and human beings.

Wind speed:

Wind speed can cause physical damage to plants and affects rate of transpiration; can contribute to dehydration in animals and can affects behavior. Stillness of air can be significant.

Soil or water nutrients, salinity:

Terrestrial plants have particular nutrient requirements.

Rainfall:

Rainfall contribute to water availability.

FOOD CHAIN

- ✓ Explain why food chains always begin with a producer.
- ✓ Describe two food chains in the environment around them

Organisms which live in a particular habitat depend on each other for their food to get their energy requirements. This transfer of energy by eating is called food chain. Food chain has biotic factors like producer, consumer, and decomposer. It always starts from producers which are sun and plants. Sun is the main component of this process because without the Sun, plants (producers) cannot make food (photosynthesis) and transfer of energy by eating will become impossible.

Thus Plants make their own food by using energy from the sun, therefore, plants are producers. Animals cannot make their own food therefore, they get energy by eating plants and animals, they are called consumers. Cows, sheep, goats, deer etc. are grazing animals; they obtain their energy by eating plants or producers so they are called primary consumers. Most humans and some animals get their energy by eating meat of these grazing animals (primary consumers) therefore they are secondary consumers. Similarly secondary consumers when eaten up by other animals then they become tertiary consumers. Food chain always starts with Sun and producers (green plants)because they prepare and provide food to herbivores. Herbivorous which feed on plants are called primary consumers and carnivorous which eat primary consumers are secondary consumers, when secondary consumers are eaten up by other animals they become tertiary consumer in a food chain.

The bodies of dead animals and plants start rotting. This process of rotting is called decomposition. Many fungi and bacteria help in the process of decomposition and are called decomposers. This process of transfer of energy from producer to consumers and then to decomposers is known as a food chain.

FOREST FOOD CHAIN

✓ Illustrate the relationship between producers and consumers.

Temperate Deciduous Forest Food Chain

Sun

Producer

Primary Consumer — Herbivore

Secondary Consumer — Omnivore

Tertiary Consumer — Carnivore

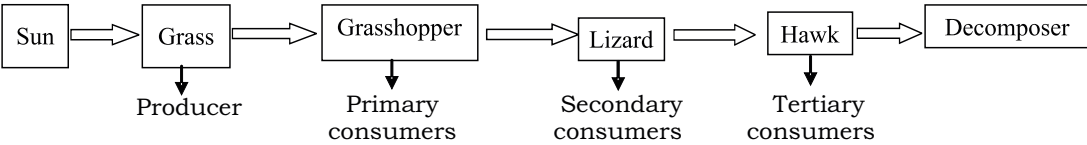
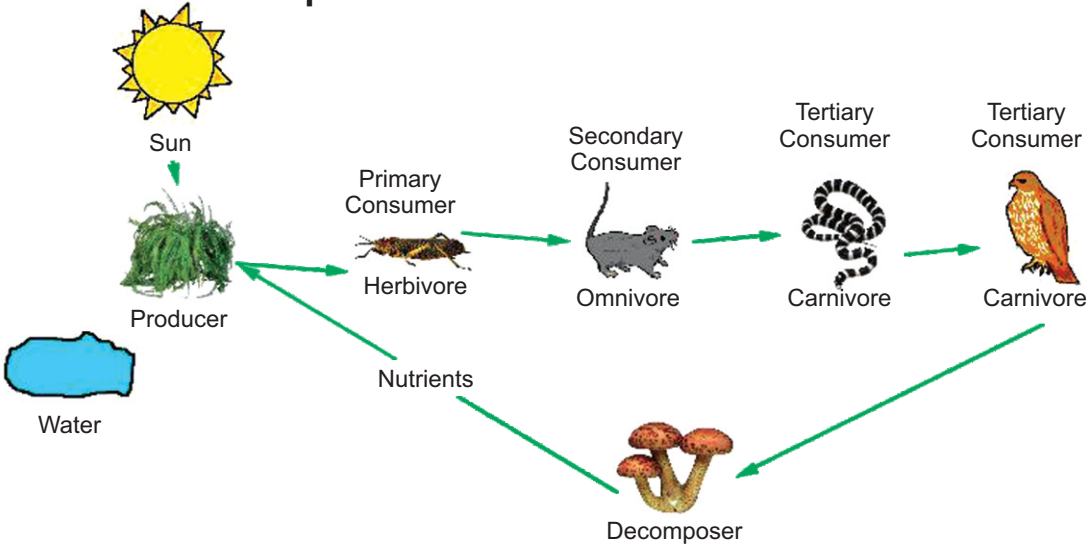
Tertiary Consumer — Carnivore

Water

Nutrients

Decomposer

Sun → Grass → Grasshopper → Lizard → Hawk → Decomposer

Sun	Grass	Grasshopper	Lizard	Hawk	Decomposer
	Producer	Primary consumers	Secondary consumers	Tertiary consumers	

Activity 4.7: Identifying abiotic and biotic factors in a pond food chain by observing given picture.

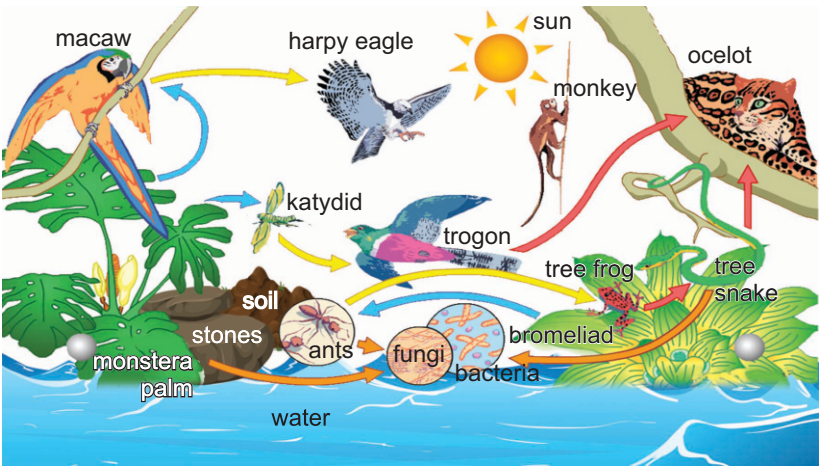



Figure 4.9 Pond food chain

What to do :

- Observe the given drawing of an ecosystem of pond and fill the table given below.
- If possible, teacher can also arrange a visit to observe river/sea and facilitate students to fill the similar table.
- Students can also visit with their parents and share their findings with the whole class.

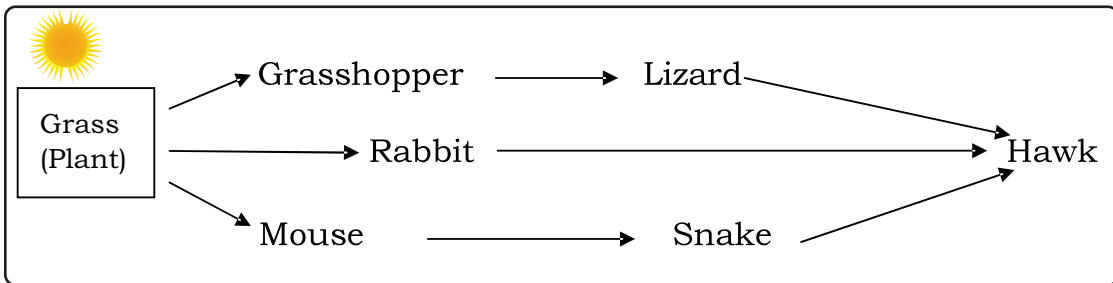
Biotic components	Abiotic components

Activity 4.8: Working in a group of 3-5.

Draw 2 food chains found around you. Compare your food chain with the other groups and discuss the reasons of difference in each food chain.

FOOD WEB

✓ Explain a food web.

In nature simple food chains occurs rarely. The same organisms may operate in the ecosystem at more than one tropic level, i.e it may derive its food from more than one source. Even the same organisms may be eaten by several organisms of a high trophic level or organisms may feed upon several different kinds of organisms of a lower trophic level. Thus in an ecosystem various food chains are linked together and intersect with each other to form a complex network called food web.

Food web

Above diagram indicates that an organism does not depend solely on another. The resources of habitat are shared specially in the beginning of food chain. The grass is eaten by a variety of animals such as grasshopper, rabbit and mouse and some of the animals are consumed by several predators. The rabbit in turn directly eaten by hawk or other predator like leopards etc. and their dead bodies are decomposed by decomposers.

In nature many alternatives are found which all together constitute some sort of inter linking pattern of the food web.

Summary

- When organisms (biotic factor) interact with non living things (abiotic factor) in an environment they form ecological system or ecosystem.
- Natural home of an organism where it lives and reproduces is its habitat.
- Plants and animals adapt to live in a particular place.
- Light intensity, temperature, water, droughts, floods, earthquakes, etc. are the factors that can bring changes in a habitat.
- Human beings are also bringing changes by polluting the environment.
- Green plants produce food through photosynthesis, therefore they are called producers. Animals eat plants so they are consumers.
- The feeding relationship among organisms is called a food chain.
- Food chain always begin with a producer, which produce food in the presence of sunlight.
- In an ecosystem several food chains overlap to form a network called food web.

Review Exercises

1. Answer the following questions:

i) What is habitat? Name different types of habitat and write their distinct features.

ii) How living organisms adapt in changing environment?

iii) Define following terms:

a) An ecosystem b) Population c) Community

iv) Describe factors that can bring daily and yearly changes in the habitat.

v) Describe adaptations of some aquatic animals to live in their habitat.

a) List the various features that allow animals and plants to live in a particular habitat

b) Explain a food chain and a food web and give at least two examples of each.

c) How people change habitat? What can be done to protect habitat?

2. Encircle the correct answer in the following :

i) The interaction of living organisms with each other and with their environment is:

(a) Ecology (b) Ecosystem (c) Habitat (d) Food Chain

ii) A place of living according to particular environment of living thing is:

(a) Ecosystem (b) Habitat
(c) Temperature (d) Ecosphere

iii) Area where river meet with sea is:

(a) Freshwater (b) Marine water
(c) Estuarine water (d) Stationary water

iv) Area below ice cap have very cold climate:

(a) Forest (b) Desert
(c) Grass land (d) Tundra

v) The food chain always starts from:

(a) Primary consumer (b) Secondary consumer
(c) Producer (d) Decomposer

CHAPTER 5

WATER

In previous, class you have studied that clean water is a colourless, odourless and tasteless at room temperature. Water is also universal solvent because a wide range of chemical substances can easily be dissolved in it.

Whether it is the climate sustenance through water cycle or serving as the raw material for the green plants during photosynthesis or being one of the basic food component of humans and different animals, a constant supply of water is crucial for life.

Have you ever thought of how you get a constant supply of clean water? What are the sources of water? What are the uses of water? Earlier, you have also studied how water becomes polluted? How could this water be cleaned? How could we get clean water?

In this Chapter you will learn about:

- Water for Life
- Sources of Water
- Impurities of Water
- Cleaning of Water (Distillation, Water Treatment Plant)
- Uses of Water (Drinking, Source of Energy-Hydroelectricity, Cooling of Heavy Mechanical Complexes)

All the students will be able to:

- ✓ Describe the ways in which clean water is vital for meeting the needs of humans and other living things.
- ✓ Identify the sources of water.
- ✓ Recognise the substances present in water that make the water impure.
- ✓ Suggest different ways to clean the impure water.
- ✓ Describe the various uses of water in our country.
- ✓ Investigate the consumption of water in our daily life and suggest ways to reduce wastage of water.

Figure 5.1: Water for life

WATER FOR LIFE

✓ Describe the ways in which clean water is vital for meeting the needs of humans and other living things.

DO YOU KNOW?

As 97.5% of water on earth is saltwater, therefore water recycling is regulated through seas and oceans.

Water is essential for carrying out many of our living activities.

Clean water is colourless, odourless, germ-free and pleasant to taste. The clean water is considered safe for drinking. Water is required for other household, industrial, agricultural and environmental activities. Water is also used for recreational activities, such as in swimming pools, artificial ponds etc.

Can you imagine a life without water? No it is not possible. Water is essential for animals and plants. Clean water is also one of the six basic food components of human beings. Other five components are carbohydrates, proteins, fats, vitamins and minerals.

Green plants need water for photosynthesis. Can you imagine a life without green plants? It is not possible to survive without green plants, which are the direct or indirect source of food for animals and human beings.

As you have learned earlier, water is the only natural substance found in three states of matter as solid (in glaciers and icebergs), liquid (in form fresh water, rivers, lakes, streams and marine water seas and oceans) and gas (in water vapours, clouds and air).This unique physical property of water is important to maintain a constant supply of water to keep the environment healthy for the growth and evolution of living things.

Activity 5.1: List out the activities in which clean water is consumed by the humans.

What I need:

Notebook, pen/pencils, colour pencils.

What to do: (Duration 2 to 3 days)

Discuss the activities among your group members, observe your surroundings, talk to your elder siblings, parents and make a list of activities in which clean water can be used.

Activity 5.2: Complete the table below. Draw the use of water and display in classroom.

What I observed:

Household Activities	Agricultural Activities	Industrial Activities	Other Activities

Activity Questions:

Which household/agricultural/industrial/environmental activities can be performed by using clean water?

Water is one of the most crucial natural substances for the existence of any form of life on earth. Clean water is the basic requirement of human beings and most of the animals and plants. It is estimated that approximately 70% of freshwater is used for crop irrigation and livestock production. Industrial use is of 20% of the freshwater, while domestic use makes up the remaining 10 %.

Saltwater or marine (sea) water also contributes in important ways in the existence of life on earth. There are thousands of the animals and plant species that live in oceans and seas. These species play a crucial role in meeting the dietary needs of human beings and other animals. For instance, seaweeds are the healthy food source for human beings and also used in the making of fertilizers. Fishes such as Pomfret, Palla, Rahu and prawns are the most popular seafoods that are great source of protein, minerals like iodine and vitamins.

Teacher Note: Help students to explore. Display and appreciate their work.

In other words, human activities are directly influenced by the quality and availability of water. It is, thus very important to learn about water management.

SOURCES OF WATER

✓ Identify the sources of water.

Pakistan is blessed with both the natural and artificial sources of water. The main natural sources are rivers, lakes, streams, rain water oceans, glaciers and wells whereas artificial sources are water reservoirs, dams and tube wells.

Figure 5.2: Water Resources in Pakistan

In order to ensure the constant availability of clean water, the conservation of freshwater sources and preservation of physical properties of saltwater sources is important.

Activity 5.3: (a) Identify the sources of clean water in Sindh.

(b) Draw a labelled map of Sindh to show these sources with the names of districts and cities in which they are located.

What I need:

Different colour pencils and paper.

What to do:

1. Make a list of the sources of clean water in Sindh.
2. Draw the map of Sindh and mention the location of the clean water sources with the name of the associated districts, cities and rural areas.
3. Highlight the different sources with different colour pencils.

Activity Questions:

1. Where are the water sources mostly located?
2. State the population, livelihood of the people, the flora(plants/vegetation) and fauna (animals/livestock) of the district and cities with fresh water sources.

IMPURITIES OF WATER

✓ Recognise the substances present in water that make the water impure.

As you have studied earlier that water gets impure by the addition of untreated sewage water from domestic use, untreated water that contains harmful chemicals from our industries and water run-off from our agriculture that contains harmful pesticides and fertilizers. These impurities in water have severed impact on the health of Pakistani citizens, plants and animals.

These impurities include undissolved and dissolved substances such as sand, clay, peat, animal mass, decomposed vegetation, crop cuttings, microorganisms that cause diseases, chemicals from industries and domestic use, metal traces, Dichloro-diphenyl, Trichloro ethane (DDT) and agricultural run-off.

These impurities in water cause waterborne diseases such as hepatitis A, B and C, amoebic and other dysenteries, diarrhoea, typhoid and naegleria infection. Similarly these impurities cause increased rate of viral infected vegetables and fruits and different fungal infections in cattle in Sindh.

DO YOU KNOW?

Improved water is a term used to define the water free of any contamination while clean water is the term used to define water free of all physical and radiological impurities, and must have chemical and biological impurities in check [as per World Health Organisation (WHO) guidelines]. Only, then clean water is safe for drinking.

Worryingly, according to the Pakistan Water Situational Analysis Report (2014), Pakistan's freshwater sources are not safe for irrigation, household and industrial activities. Although, since 1990 access to improved water has been raised from 85% to 92%, still 64% rural population does not have access to drinkable water.

Water is termed as polluted water when it has any or all undesired and harmful physical, chemical and biological impurities. These impurities include disease causing microbes, clays, peat (decomposed vegetation, animal dung) sand particles and chemicals, such as metals and DDT.

CLEANING OF WATER

✓ Suggest different ways to clean the impure water.

Cleaning of water is essential to meet the vital needs of human beings and other living things. Is your drinking water improved or clean water?

You have studied earlier that the impurities remain either dissolved or undissolved in water. You have also studied that a variety of water cleaning methods used at domestic and commercial levels. The most commonly used water cleaning methods are boiling of water, filtration, distillation, chlorination, use of water purification tablets and potash alum. The use of portable and fixating water purifiers is common in the urban population.

Domestic Methods of Cleaning of Water:

Boiling: In villages and other less-privileged areas, boiling can easily be used to make water drinkable. Water is boiled for 15-20 minutes to kill disease causing microbes.

Potash Alum: It is used to clean water by sticking physical impurities together. As the impurities stick together to form large particles, these large enough particles settle down and are filtered.

Water Purifiers: Water purifiers are multi-effect water treatment systems, use filtration, Reverse Osmosis (RO), ionization and Ultra Violet (UV) rays to purify water for drinking and medicinal uses. Two examples of portable water purifiers are shown in figure 5.3 (a) and (b).

Figure 5.3 (a): Water filter using 4 stages-filtration

Figure 5.3 (b): Water purifier, using Ultra Violet (UV), RO and biocide (Agent to kill pathogenic microorganisms)

Water Purification Tablets:

Water purification tablets such as NaDCC (Sodium Dichloro isocyanurate) or Halazone tablets are also used to clean water by sticking physical impurities together. These tablets deactivate bacteria and viruses to make water drinkable.

Commercial Methods of Cleaning of Water:

Filtration: Filtration is the most primitive and effective method of removing suspended sand particles and insoluble physical impurities from water. These particles and impurities are removed by using filter paper as shown in figure 5.3 (c). However, many modifications in simple filtration have increased its efficiency. One such example is the addition of bio-film in the traditional yet effective filtration system that removes biological impurities as shown in figure 5.3 (d).

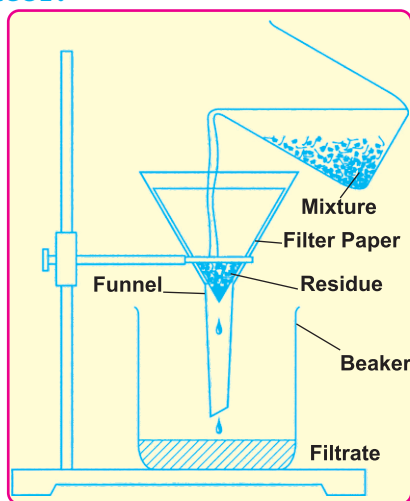



Figure 5.3 (c): Filtration by filter paper

Wood or metal cover
ntaminated water
Diffuser plate slows water flow to ensure it passes through bio-film layer gradually
e bio-film
e of sand
thogens)
Outler piope and tap for clean water
Sand
Coarse sand layer
Gravel
oncrete body cast site in shuttering mould

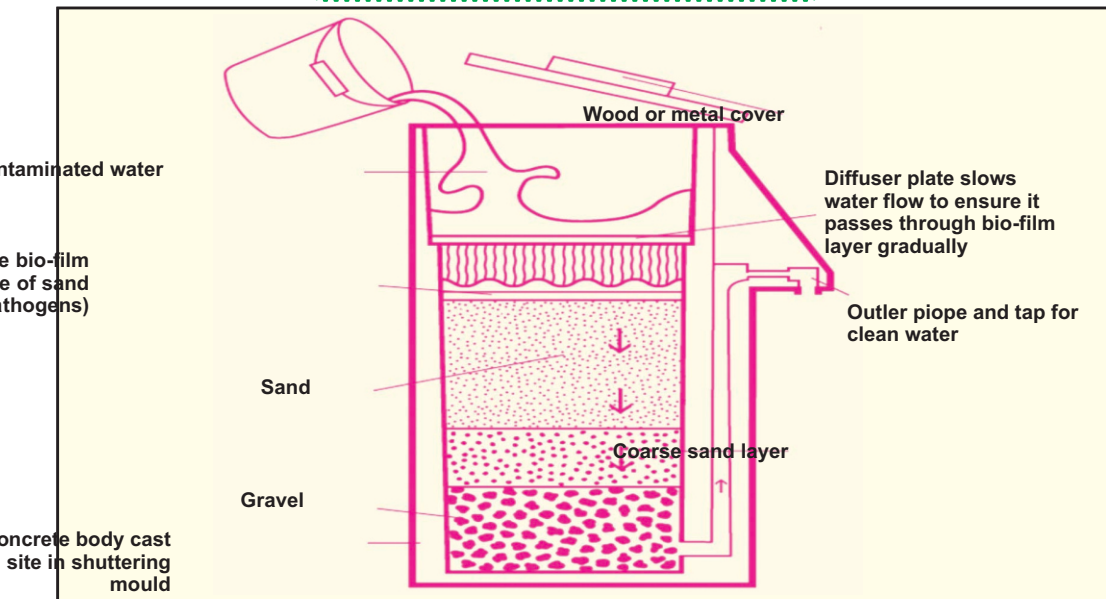



Figure 5.3 (d): Multi-stage filtration with a low-cost bio-film-A

Chlorination: Chlorination is another way to kill harmful microorganisms. It prevents the spread of water born diseases such as cholera, dysentery, typhoid etc. Liquid chlorine is mixed in the impure water to kill disease causing microorganisms. Use of chlorine oxide (ClO_2) and hypochlorite ions (ClO^-) makes water safe for the domestic use.

Distillation: Distillation is used to remove dissolved physical and chemical impurities from water. These impurities are removed by evaporating and condensing the polluted or impure water as shown in figure 5.3 (e). Distilled water is used for sterilizers as well as for preparing food for the patients. In laboratories, it is used in the preparation of suspensions and other medicines. However, distilled water is not advisable for the drinking. Can you find the reason, why is distilled water not advisable for the drinking.

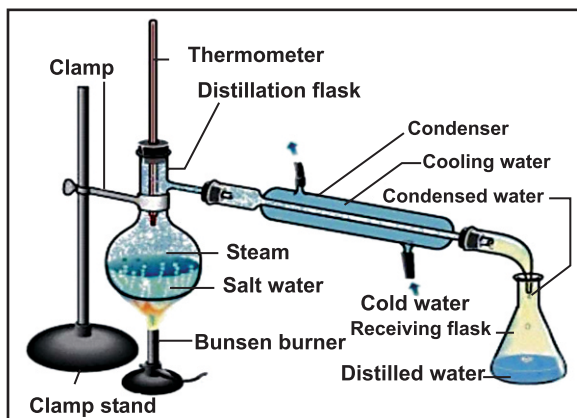



Figure 5.3 (e): Distillation in laboratory

Activity 5.4: Demonstrate cleaning of water through distillation

What I need:

1. One steel pot (diameter 12 inches) with compressed lid
2. A glass bowl (diameter 6-8 inches)
3. Salt solution (dissolve some salt into 3 litre of tap water) or salt water (3 litre)
4. Ice cubes
5. Stove and match box or lighter

ice cubes
bowl

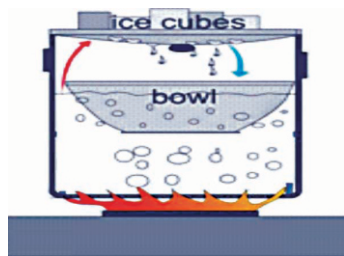



Figure 5.4 Collection of distilled water

What to do:

- Fill the pot with 3 litre of salt solution/salt water.
- Place the pot on the stove.
- Put the glass bowl in the pot (it should be floating on water).
- Cover the pot with lid (as shown in figure 5.4).
- Turn the stove on and let the water boil. When the sound of the popping water bubbles is heard, put ice cubes on the lid as shown in figure 5.4.

What I observed:

The steam will rise and strike to the inner part of the lid. As the lid must be cold due to the ice cubes, therefore steam will get condensed into pure water and fall in the bowl as shown in figure 5.4.

Activity Questions:

- Is distillation an adaptable method of water cleaning at small scale?
- How does distillation work to clean/purify water?

What I concluded:

Water cleaning plant:

In Pakistan to ensure supply of safe water to the rural and urban population several water cleaning plants are placed at different locations. These plants use multiple methods of water cleaning to remove physical, chemical and biological impurities from the water.

In Sindh, three different water qualities are maintained to serve the following purposes:

(i) Improved water is used for the irrigation and commercial purposes including cooling of minerals and watering of sports grounds and public parks.

(ii) Clean water is used for drinking, other household and pharmaceutical activities.

(iii) Desalinated Arabian Sea water is used for household, industrial and recreational activities.

There are two ways of cleaning water.

1. Reverse Osmosis Filtration Plant:

Recently, the government of Sindh has installed a large number of the solar-powered reverse osmosis water filtration plants. These plants use reverse osmosis filtration method to remove physical, chemical and biological impurities and softening the underground water. Huge water tanks are being built near villages to make the clean water available for the drinking as well as other household activities.

DO YOU KNOW?

Osmosis is a process by which a solvent passes through a porous membrane.
Reverse Osmosis (RO) is a water purification technology that uses a semipermeable membrane to remove ions, molecules, and larger particles from drinking water.

Figure 5.5: Solar-powered RO filtration plant

2. Water Treatment Plant

Water treatment plant (as shown in figure 5.6) use multiple methods to remove hazardous chemicals, microorganisms, suspended particles of soil, peat, pesticides and many such contaminants. At first freshwater from a lake or reservoir is introduced to flocculation plant where flocculates are added to this water. These flocculates cause dust and pesticides to stick together.

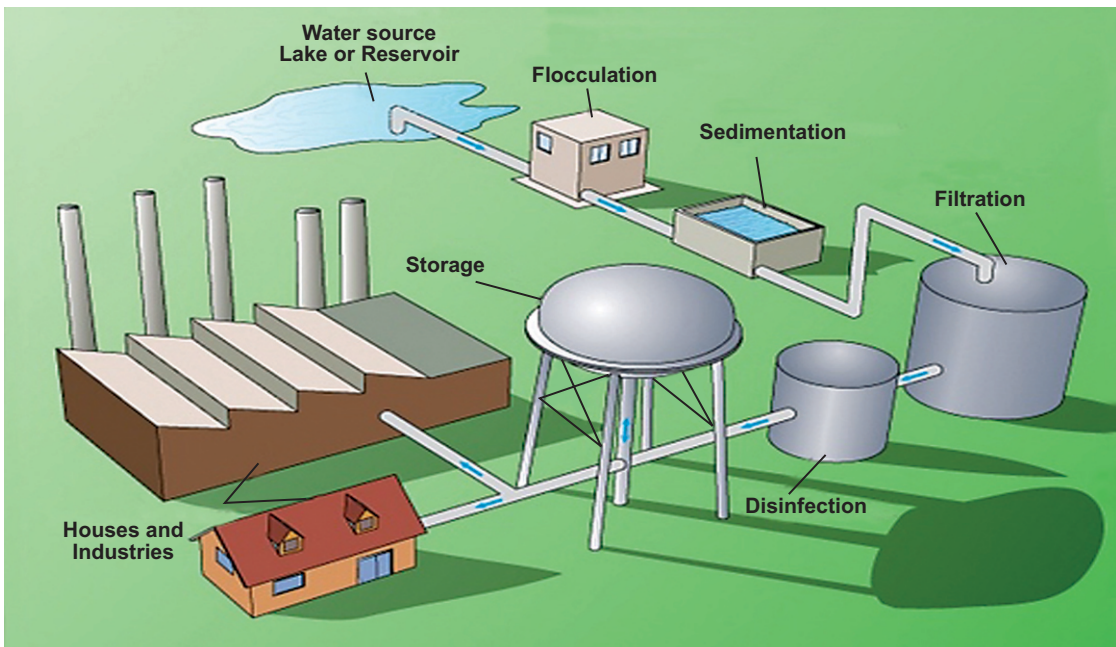



Figure 5.6: Drinking water treatment plant

Then, this water is transferred to the sedimentation tank and allows water to sit for 24 hours. This process helps in settling the particles down in the tank and clears the turbidity of freshwater along with flocculated pesticides. Now water is introduced into filter plant that has layers of charcoal, gravel and sand. When water seeps through these filters, all small particles are removed. At the last stage, water is transferred to the disinfectant tank to kill pathogenic microorganisms. Sometimes, minerals such as fluoride and sodium salts are added to the water to make it healthy and palatable.

USES OF WATER

✓ Describe the various uses of water in our country.

In Pakistan, usage of water can be divided into four broad categories:

(i) Agricultural Use: Approximately 93% of water is used in agricultural activities including irrigation of land, cattle farming and production of dairy food.

(ii) Industrial or Commercial Use: Approximately 5% of water is used in industry including food, pharmaceutical, textile, chemical industries and watering of public parks, sports complexes, wetland and amusement parks.

Water is the most efficient and economical coolant, used in heavy mechanical industries and nuclear reactors.

(iii) Domestic Use: Approximately 2% of water is available for the domestic use including drinking, cooking, cleaning, washing, bathing and other household activities.

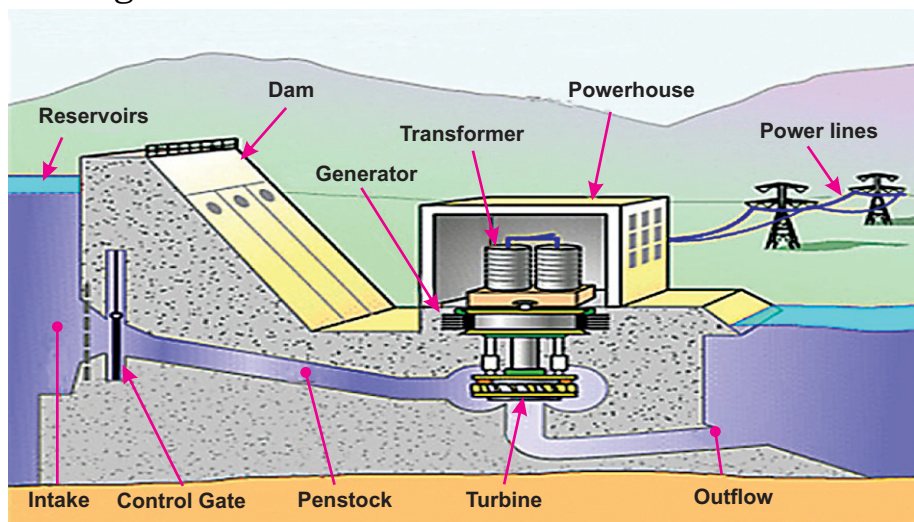



Figure 5.7 Hydroelectric power production

(iv) Hydroelectric Use: Water stored in reservoirs (such as dams) is used for the electric power production as shown in figure 5.7.

DO YOU KNOW?

Approximately 6913 Mega Watt of electricity is produced by different hydro power plants located at different regions of Pakistan.

CONSUMPTION OF WATER IN DAILY HUMAN LIFE

✓ Investigate the consumption of water in the daily human life and suggest ways to reduce wastage of water.

We use about 12% of water for drinking and cooking, 25% in washing, whereas 56% is used in bathrooms and toilets. About 2% water is used for plants in home but 5% is wasted through leakage of pipes. Figure 5.8 shows consumption of water in daily human life.

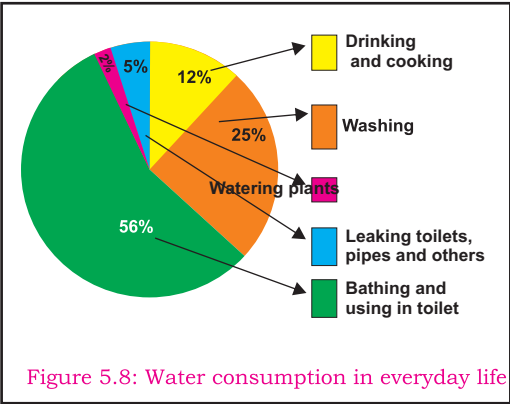



Figure 5.8: Water consumption in everyday life

Activity 5.5: Investigate the consumption of clean water in our daily life and suggest the ways to reduce wastage of water.

What I need:

Notebook, pen/pencil.

What to do:

Observe and enlist the daily activities in which clean water is consumed. Here, daily activities include household activities as well as the activities at school.

Now, identify the daily activities in which you and your family waste water.

Think a different techniques to reduce this daily wastage of water.

Make a list of the most effective and easily adaptable ways to reduce the wastage of water.

What I observed:

S.No.	Activities in which water is consumed on daily basis	Ways, water is wasted in the daily consumption	Ways to reduce the wastage of water

Activity Questions:

1. Name the ways and activities for which you consume water at the most on the daily basis.
2. How is water wasted at most in your daily consumption?
3. How can the wastage of water be reduced at your home and school?

Ways to Reduce Wastage of Water:

Water scarcity is a global issue. Unfortunately, Pakistan is one of the top 20 countries under fierce threat of water scarcity. We need to be more vigilant in managing our water resources. Following are some effective ways to reduce wastage of water in our daily lives:

(i) Make sure, there is no leakage of water storage tanks, utensils and pipe lines.

(ii) Do not leave the water running while doing ablution or washing face and hands.

(iii) Use water carefully in bathing. If you have a shower, then take short showers. Do not leave the shower on while applying soap on your body.

(iv) Do not leave the water running while you are washing the dishes or clothes or cleaning vegetables and fruits. It would be wise to take water in a bucket to clean vegetables and fruits.

(v) If using the washing machine, use it for only full loads.

(vi) Water your lawns or potted plants in early hours or after 3:00 O'clock in the afternoon. It will help to restore their moisture for long.

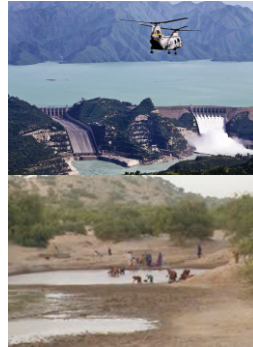
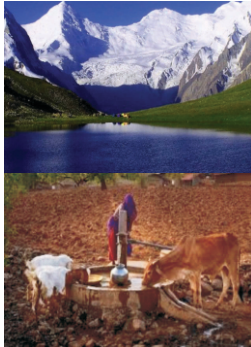
(vii) Use drought-resistant plants and shrubs for your lawns and home plantation.

Teacher Note: Ask each student to investigate the ways and activities for which she/he and their families consume water in their daily life.

Summary

Water (H_2O)
(The most abundant natural source, essential for life)
Crucial for keeping environment healthy, used by green plants for photosynthesis, one of the basic food components of humans and animals.

Freshwater (3% of total Surface Water)

Saltwater (97% of total Surface Water)

Water Resources in Pakistan

Impurities in Pakistani Water Sources
Clay, peat, sand particles, disease causing pesticide, chemicals such as traces of metals and DDT.

Cleaning of Water

Domestic Level
Boiling of water, using potash alum or water purification tablets and water purifiers.

Commercial Level
Chlorination, filtration and distillation and water cleaning plants such as Tharparkar's RO filtration plant.

Uses of Water
Used in household, agricultural, industrial, recreational and environmental activities such as drinking, cooking, bathing, washing, cultivation of crops, watering of decorative plants, parks and sports grounds/ complexes, cooling of heavy mechanical complexes and nuclear reactors, pharmaceutical industry, hospitals, and in swimming pools and water-parks.

Review Exercises

1. Fill in the blanks:

   a) The process of water seepage in the land is called_____________.

   b) In water cleaning plants, sand particles and pesticides are stuck together by using ____________.

   c) Water is boiled for _____________minutes to use it for drinking purpose.

   d) Seaweed is one of the important source of proteins, minerals of _______________and vitamins.

2. Match the statements of column A with column B:

Column A	Column B
Potash Alum	Is used to remove dissolved physical and chemical substances.
Liquid Chlorine	Is used to kill harmful microorganisms.
Distillation	Is used to clean water by sticking physical impurities together to form large particles.

3. Explain the factors responsible for:

   a) Depleting freshwater sources in Pakistan.

   b) Deteriorating water-quality of clean water sources in Pakistan.

4. Describe the ways in which water is vital for the life of animals and plants.

5. Explain, Why:

   a) Boiled water is safe for drinking and cooking.

   b) Saltwater is desalinated.

   c) Clean water is important for sustainable healthy climate.

6. Suggest five ways to reduce the wastage of water in daily life.

7. Explain the processes of cleaning water in water treatment plants.

PROJECT

Use the following materials and design a model of water purification plant:

RO filters/semi permeable membranes, transparent water jars pipes for connecting different apparatus (having tap water and for storing clean water); flocculants such as Alum.

a) Make a labelled diagram of your model of water cleaning system.

b) Make a list of physical, chemical and biological impurities which can be removed by your designed water cleaning plant.

c) Describe how your model works.

d) Make a poster for advertisement of your water purification model plan in the school.

CHAPTER 6

STRUCTURE OF AN ATOM

You have learnt that all matter on earth consists of elements. Elements are simplest kind of matter which cannot be further split up into simpler substances by chemical reactions. The smallest particle of an element is called an atom. Let us explore what are atoms, what do they contain and how do they behave?

In this Chapter you will learn about:

- Structure of an atom (Protons, neutrons and electrons)
- Atomic Number and Mass Number
- Distribution of Electrons in shells (K,L,M only) using $2n^2$ Formula (1-18 Elements)
- Valency and Ions
- Isotopes and their uses
- Chemical Formulae
- Law of constant composition

All the students will be able to:

- ✓ Describe the Structure of an atom.
- ✓ Differentiate between atomic number and mass numbers.
- ✓ Draw diagrams of the atomic structure of the first eighteen elements in the periodic table.
- ✓ Define valency.
- ✓ Explain formation of ions.
- ✓ Differentiate between cations and anions.
- ✓ Describe isotopes and their uses in medicine and agriculture.
- ✓ Identify the types and number of elements present in simple molecules and compounds.
- ✓ Make chemical formulae from list of anions and cations.
- ✓ State the law of constant composition and give examples.

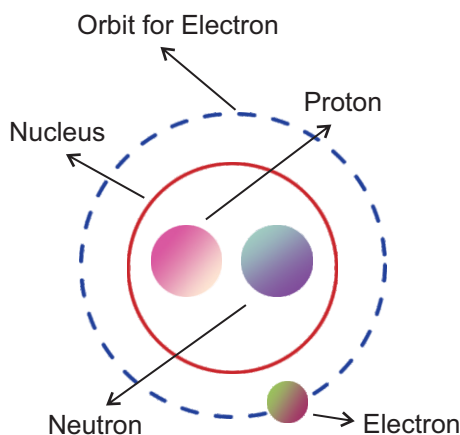



Fig 6.1
Structure of an Atom

Fig 6.2 Everything is made up of different kinds of atoms

STRUCTURE OF AN ATOM

✓ Describe the Structure of an atom.

An atom is an extremely small particle of matter that cannot be subdivided by ordinary means. The atoms of different elements have different sizes. However, each atom is made up of smaller particles called "subatomic particles" i.e. protons, neutrons and electrons. Atoms have equal number of protons and electrons e.g. an atom of hydrogen has one proton and one electron, an atom of nitrogen has seven protons and seven electrons.

Nucleus:

All atoms have a small dense positively charged nucleus in their centers. All the mass or weight of an atom is concentrated in the nucleus due to the presence of neutrons and protons which are about 1836 times heavier than electrons. The nucleus is very much smaller than the atom as a whole.

Proton:

Proton has positive charge and its mass is one atomic mass unit (1amu). The number of protons in an atom is always equal to the number of electrons in it.

Fig 6.3 Structure of carbon atom

Neutron:

Neutron has no charge. Protons and neutrons have almost same mass 1amu. They are collectively known as nucleons.

Electron:

The electrons are arranged in shells around the nucleus. They revolve or whirl in these fixed shells or orbits around the nucleus. The electrons have a negative electric charge. An atom has the same number of electrons and protons.

ATOMIC NUMBER AND MASS NUMBER

✓ Differentiate between atomic number and mass number.

Atomic Number:

The specific number of protons present in the nucleus of every atom is called its atomic number. It is represented by the symbol 'Z'. Carbon atom has 6 protons inside the nucleus see Fig 6.3. Therefore, its atomic number is 6. The number of protons are also equal to the number of electrons present in an atom.

Mass Number:

Mass number is the sum of protons and neutrons in the nucleus of an atom. It is represented by "A". Again observe figure 6.3, where the carbon atom has 6 protons and 6 neutrons in its nucleus so, the total number of protons and neutrons become 12. Therefore, the mass number or the nucleon number of carbon is 12.

A=Z+N

Number of protons (Z) = 6

Number of neutrons (N) = 6

Mass number of Carbon (A) = 6 + 6 = 12

The difference between the mass number 'A' and the atomic number 'Z' of an atom gives the number of neutrons 'N'. Thus,

N=A-Z

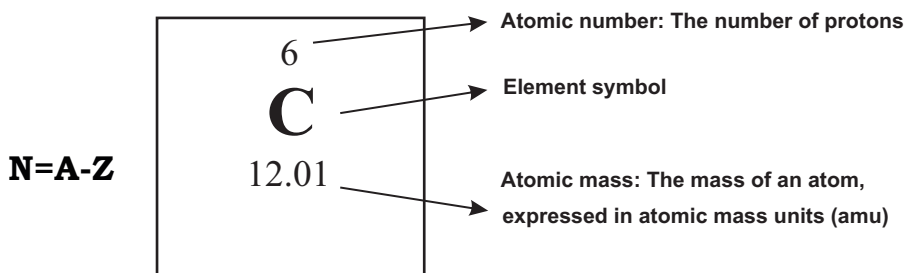
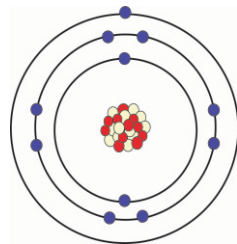



Figure 6.4 Representation of an element Carbon and its atomic and mass numbers

Activity 6.1: Answer the following questions by observing the following figure and using the periodic table:

Number of Electrons= 11
Number of Neutron= 12
Number of Proton= ?

The given atomic structure represents which element? ___________
Write its atomic number and mass number: Z = ______; A = _______
Write the number of protrons__________.

THE PERIODIC TABLE

✓Draw diagrams of the atomic structure of the first eighteen elements in the periodic table.

DO YOU KNOW?
We can observe surface of an object at atomic level with special type of microscope called, the Scanning Tunneling Microscope (STM) developed in 1981.

Periodic table is a chart of all the known elements in which elements are categorized into groups of similar chemical properties in the order of increasing atomic numbers (See figure 6.5). There are rows of different colours and they go from left to right. Row is considered to be a period. All the periods in a row has same number of atomic shells. The periodic table has columns from top to bottom called groups. The elements in a group have the same number of electrons in their outer most shell.

Part of the periodic table

1 H 1							4 He 2
7 Li 3	9 Be 4	11 B 5	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
23 Na 11	24 Mg 12	27 Al 13	28 Si 14	31 P 15	32 S 16	35.5 Cl 17	40 Ar 18

Key: atomic mass — 4; He; atomic number — 2

Figure 6.5 Part of periodic table

Activity 6.2: Draw diagrams of atomic structure of first 18 elements in the periodic table

What I need:

- Periodic table
- Exercise Book
- Coloured pencils/ markers
- Compass for drawing circles

What to do:

- Observe the Fig 6.5 part of periodic table.
- Draw diagrams of all 18 elements in your note book with the help of atomic number and mass number.
- Show it to the teacher and share with the whole class.

VALENCY

✓ Define valency.

Valency is the power of combining of an atom with other atoms to form molecules or compounds .

An atom may need to gain or lose an electron from its outermost or valence shell, which has to complete its outermost shell, so that it will be like noble gases. This tendency to lose or gain an electron is also called valency.

Sodium has a valency of 1 because it has tendency to lose one electron from its valence shell (figure 6.6(a)).

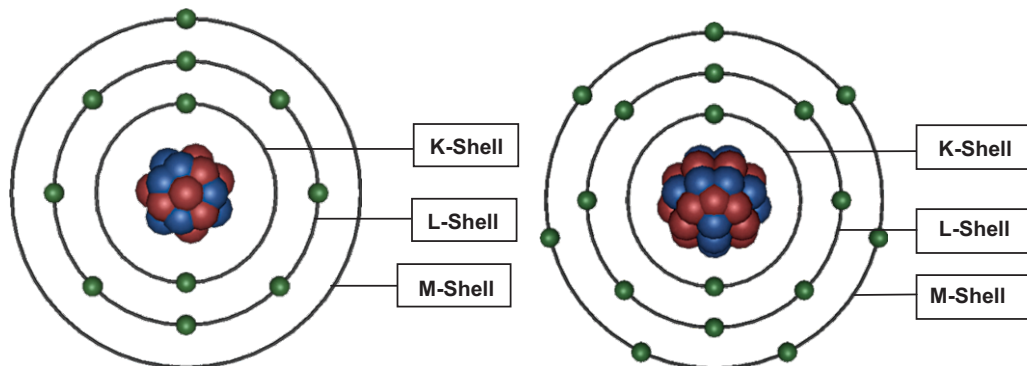



Figure 6.6 a) Atomic structure of sodium

Figure 6.6 b) Atomic structure of chlorine

Chlorine has a valency1 because it has tendency to gain one electron. If it gains an electron its valence shell becomes complete (figure 6.6(b)).

Distribution of electrons in shells using $2n^2$ formula:

Electrons revolve around the nucleus in definite paths called orbits or shells. Each shell can contain only a fixed number of electrons. The formula '$2n^2$' is used to calculate the maximum number of electrons that an orbit can possesses where 'n' indicates the position of the orbit from nucleus.

Number of orbit(n)	Names of orbits	$2n^2$	Maximum number of electrons
1	K	2×1^2	2
2	L	2×2^2	8
3	M	2×3^2	18

The first orbit, which is closest to nucleus is called K shell. The second shell is called L shell, likewise the third shell is called M shell.

IONS

- ✓ Explain formation of ions.
- ✓ Differentiate between cations and anions.

An atom is neutral but when an atom or molecule that carries net electric charge due to gain or loss of an electron is called an ion. Atoms which lose electrons will become positively charged ion and are known as cations. (figure 6.7 (a)).The size of a cation is smaller than that of its parent neutral atom.

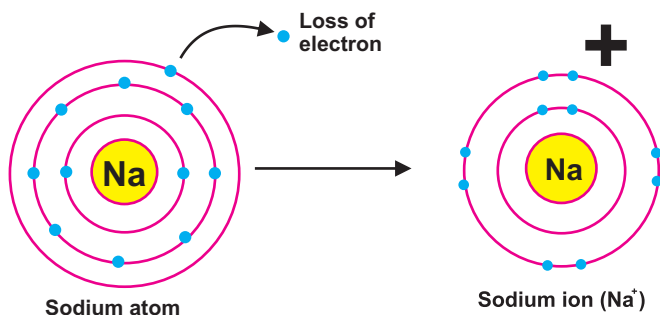



Figure 6.7. (a) Formation of sodium ion

Atoms which gain electron will become negatively charged and form negative ion which is called anion. As shown in Figure 6.7 (b). The size of an anion is greater than that of its parent neutral atom.

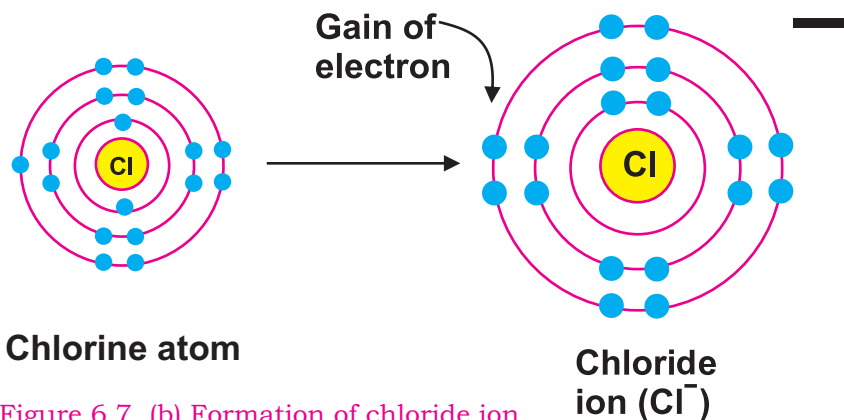



Figure 6.7. (b) Formation of chloride ion

✓ Make chemical formulae from list of anions and cations.

The table 6.1 shows some common anions and cations.

Charge of ion	Name of ion	Symbol of ion	Number of electrons lost or gained by atom
+1	Hydrogen	H^+	Lost one electron
	Lithium	Li^+	
	Sodium	Na^+	
+2	Beryllium	Be^{++}	Lost two electrons
	Magnesium	Mg^{++}	
+3	Boron	B^{+++}	Lost three electrons
	Aluminum	Al^{+++}	
-1	Chloride	Cl^-	Gained one electron
	Fluoride	Fl^-	
-2	Oxide	O^{--}	Gained two electrons
	Sulphide	S^{--}	

Activity 6.3: Complete the following table

Name of Compound	Chemical Formula	Elements	No. of Atoms of each Element
Carbon mono oxide	CO	Carbon, Oxygen	1 Carbon, 1 Oxygen
Ammonia	NH_3		
Water	H_2O		
Sodium chloride	NaCl		
Calcium chloride	$CaCl_2$		

Activity 6.4:

Write the names and chemical formulae of at least 10 molecules with the help of list of cations and anions given in Table 6.1

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________

ISOTOPES

✓ Describe isotopes and their uses in medicine and agriculture.

The atoms of same element which have the same atomic number but different mass numbers are known as "isotopes".
Isotopes are represented by following symbol:

$^{1}_{1}H$ $^{2}_{1}H$ $^{3}_{1}H$

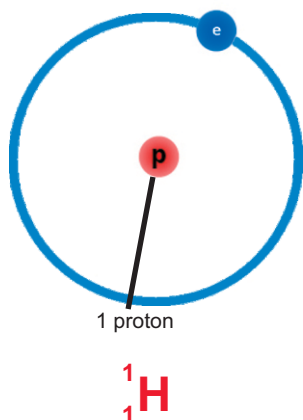
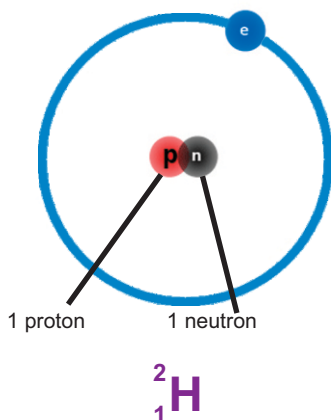
Figure: 6.8 (a) Isotops of hydrogen

X = element symbol

Z = atomic number (number of protons)

A = mass number (number of protons + number of neutrons)

Teacher Note: Teacher should make groups or pair of students according to class size and facilitate them to work collaboratively by sharing ideas and actively working together.

Thus, ordinary hydrogen or protium is written as $^{1}_{1}H$, deuterium is isotope of hydrogren written as $^{2}_{1}H$ and tritium as $^{3}_{1}H$.

6.8 (b). Isotopes of Hydrogen- Protium, deuterium and tritium

The atomic structures of carbon isotopes are shown in the figure 6.8(c). Carbon atoms exist naturally with 6, 7 or 8 neutrons. Since each atom of carbon has 6 protons, its isotopes have atomic masses 12, 13 and 14. These isotopes are called carbon-12, carbon-13 and carbon-14, respectively. Alternatively, they may be written as ^{12}C, ^{13}C and ^{14}C.

Different mass numbers

$^{12}_{6}C$ $^{13}_{6}C$ $^{14}_{6}C$

Same atomic number

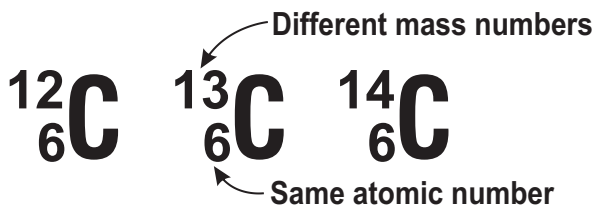



Fig 6.8 (c) Isotopes of carbon

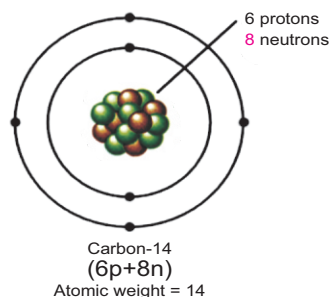
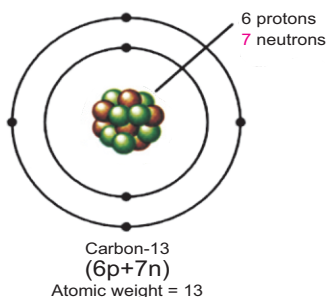
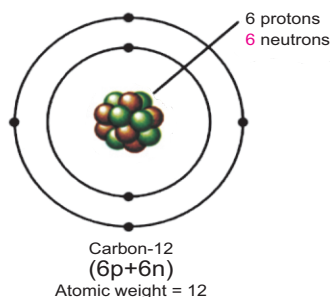



Figure 6.8(d) Isotopes of carbon

Uses of isotopes:

Uses in Medicine:

Sr. No	Isotopes (Symbols)	Uses
1.	Copper – 64 (^{64}Cu)	Used for diagnosis and treatment of various diseases, for example in Wilson's disease, which is a hereditary disorder. This isotope helps in detection of copper retention in the body. Copper isotope is used to kill cancer cells by a particular type of treatment, known as radiotherapy.
2.	Gallium – 67	Used for detection of prolonged infection and cancer cells .
3.	Cobalt – 60	Used for radiotherapy to stop the growth of cancer cells.
4.	Iron – 59	Used in studies of iron metabolism and proper functioning of red blood cells (RBCs).
5.	Iodine – 123	Used for diagnosis of function of thyroid gland.

Uses in Agricultures:

Sr. No.	Isotopes	Uses
1.	Nitrogen – 15	Used to identify efficiency rates of organic and inorganic fertilizers.
2.	Phosphorous – 32	Used to study the uptake of phosphorous containing fertilizers.
3.	Carbon – 14	Used to investigate carbon uptake and biochemical pathways in plants. Carbon dating is also used for the estimation of the age of fossils.
4.	Lead – 210	Used to determine the accumulation rates of pollutants in layers of soil.
5.	Iron Copper Cobalt	Used to determine quantitatively the micro-nutrient uptake by plants

MOLECULE

✓ Identify the types and number of elements present in simple molecules and compounds.

A molecule is formed when two or more same or different atoms join together chemically. Some molecules consist of two atoms of the same element (O_2,Cl_2), while other molecules like water (H_2O), methane (CH_4) etc consist of different atoms. Simple molecules of oxygen (O_2)and chlorine (Cl_2)are shown in figure 6.9.

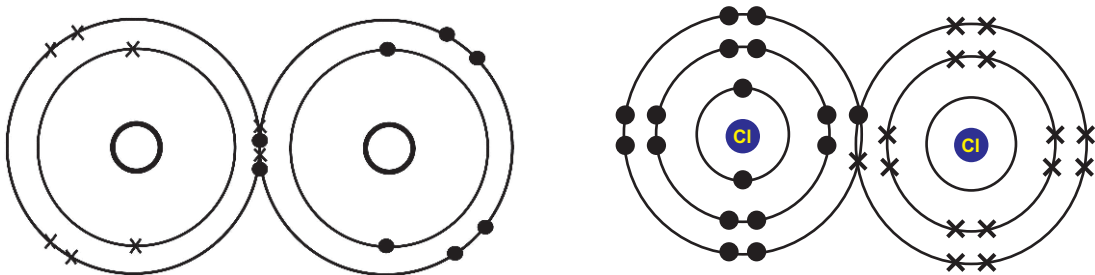



Figure 6.9 Molecules of oxygen and chlorine

Compound:

Compound is a molecule that contains atoms of at least two different elements.

Water (H_2O), carbon dioxide (CO_2) and methane (CH_4) are compounds because each is made from more than one element. Water (H_2O) is composed of two atoms of hydrogen and one atom of oxygen.

The simple compound of hydrochloric acid (HCl) and sodium chloride (NaCl) are shown in figure 6.10.

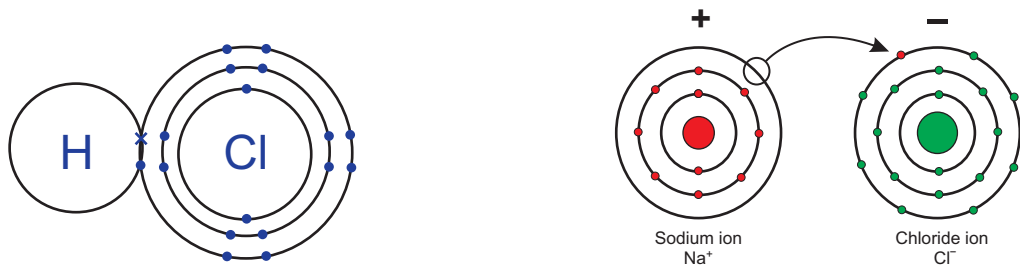



Figure 6.10 Hydrochloric acid (HCl) and sodium chloride NaCl molecules/compounds

CHEMICAL FORMULA

✓ Make chemical formulae from list of anions and cations.

The symbolic representation of molecule or compound is called chemical formula. The formula shows the constituent elements and their exact number of atoms present in a molecule or a compound.
The chemical formula of water is explained below:

H_2O

Two hydrogen atoms are present in one molecule of water.

Only one oxygen atom is present in one water molecule.

Chemical formula of water

Similarly, when sodium and chloride ions are combined in the ratio of 1:1, we get common salt which has the chemical formula NaCl.

LAW OF CONSTANT COMPOSITION

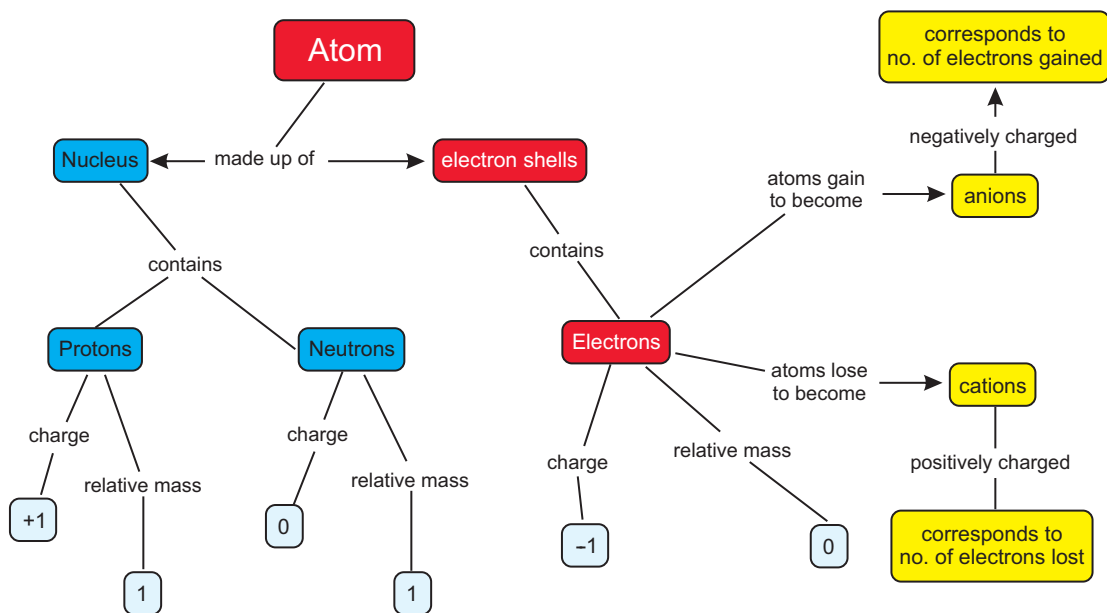
✓ State the law of constant composition and give examples.

"A chemical compound always contains the same elements combined together in the same proportion or ratio." For example, clean water obtained from different sources such as river, well, spring, sea, etc., always made up of 2 hydrogen atoms and one oxygen atom in the ratio of 2:1. Similarly, carbon dioxide (CO_2) can be obtained by different methods such as: burning of carbon, heating of lime stone, reaction of HCl with marble pieces.

However, each sample of CO_2 contains carbon and oxygen in the ratio of 1:2

Similarly, in any compound, all samples of that compound will be made up of the same elements in the same proportion or ratio with each other. When elements combine, they combine in the ratio of small whole number. For example any water molecule is always made up of two Hydrogen atoms and one Oxygen atom in a ratio 2:1.

The formula of calcium chloride is $CaCl_2$; the ratio of Ca to Cl is 1:2.
The formula of Magnesium oxide is MgO, the ratio of Mg to O is 1:1.

Summary

Review Exercises

1. Write short answers of the following questions:

i) Which particles are found within the nucleus of an atom? What electrical charges do they carry?

ii) Name particles which revolve around the nucleus of an atom?

iii) Why atom is neutral?

iv) Draw the atomic structures of the following elements:
(a)Magnesium (b) Silicon (c) Sulphur (d) Calcium (e) Aluminium

v) Differentiate between cations and anions.

2. Complete the table below.

Sr. No.	Atom	Ion	No.of protons in ion	No. of electrons in ion
1.	Chlorine			
2.	Sodium			
3.	Potassium			

3. How many electrons do the following elements have in their valence shells? Write down their valencies.

(a) Nitrogen (b) Helium (c) Lithium.

4. Which element has one electron in its outermost shell?

5. Write down the number of carbon and hydrogen atoms in methane?

6. Write down the chemical formula of ammonia molecule, which contains one nitrogen and three hydrogen atoms.

7. Complete the table:

S. No	Compounds	Chemical formula	Elements	Ratios between atoms
1	Water	H_2O		
2	Aluminium oxide	Al_2O_3		
3	Calcium oxide	CaO		
4	Hydrochloric acid	HCl		
5	Calcium floride	CaF_2		

8. Choose the correct answer from the given choices.

a) The entire mass of an atom is concentrated in the center of an atom called ____________.

Nucleus, Orbit, Neutron.

b) The mass of an atom is determined by ____________.

Neutron + Electron, Electron + Proton, Neutron + Proton.

c) Atoms of same element having different mass number are called ____________.

Anions, Cations, Isotopes

d) Chemical formula shows _____________.

Number of atoms in a molecule, Number of atoms of each element, Number of atoms in a compound

e) An atom has atomic number16 and mass number 32, the number of protons is ________________. 16, 32,18

9. Fill in the following chart.

Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Symbol of element	Isotope
6	12					
	24	12				
	35			17		
13			14			

PROJECT

MODEL MAKING

What I need:

Beads/small size balls of two different colors to represent different elements.

Wires to make orbits

What to do:

Show atomic structures of calcium, magnesium, sodium and chlorine atoms by preparing models.

CHAPTER

7 PHYSICAL AND CHEMICAL CHANGES

In the previous class, you have studied about many changes taking place in matter such as; melting, freezing, boiling, evaporation and condensation. Why these changes take place? Can you recall what causes these changes? Were these changes reversible or irreversible? Were these changes in the physical properties, appearance and state or in the chemical composition? Have you observed a burning candle? Is this change reversible or irreversible? Can you get the same quantity of wax after the burning of candle? Does any new substance formed during burning? How can we apply the process of changes in matter in our daily life? Let us explore.

In this Chapter you will learn about:

- Physical and chemical changes.
- Applications of chemical changes and processes (changing raw materials into useful products hydrocarbons, fats, fertilizers, plastics)
- Reversible and irreversible Changes.

All the students will be able to:

- ✓ Differences between physical and chemical changes.
- ✓ Identify the physical and chemical changes taking place in environment.
- ✓ Explain the use of hydrocarbons as fuels.
- ✓ Explain the physical and chemical properties of fertilizers, which make them useful in agriculture.
- ✓ Discuss harmful effects of improper use of fertilizers.
- ✓ Describe the processes in which vegetable oil changes into fat.
- ✓ Describe the simple chemical process for manufacture of plastics.
- ✓ Distinguish between reversible and irreversible changes in materials.
- ✓ Identify a variety of reversible and irreversible changes in materials in their surroundings.

Fig 7.1(a) : Physical changes.

Fig 7.1(b) : Chemical changes.

PHYSICAL AND CHEMICAL CHANGES

✓ Differentiate between physical and chemical change.
✓ Distinguish between reversible and irreversible changes in materials.

Many changes occur in matter around us. Some changes are very rapid and some are very slow. Some changes are reversible and others are not. These changes in matter are of two types:

1. Physical change.
2. Chemical change.

How would you recognize a physical change?

How would you recognize a chemical change?

DO YOU KNOW?

Physical and chemical changes happen in the world around you and not just in a science laboratory. Matter changes its states through a process called physical change. Matter also interacts with other matter to form new substances through a process called a chemical reaction or chemical change.

Table 7.1 The sign of physical and chemical changes.

Signs of a physical change	Signs of a chemical change
• Change that can be reversed. • The substance does not turn into a new substance.	• A release of gas. • Change in colour. • Change in temperature. • Change in smell. • Production of a new material.

INVESTIGATE

Observe your surrounding:
Make a list of physical and chemical changes happening all around you.

(1) Physical Change:

Physical change is a change in physical appearance or state of a substance. It does not affect the composition and the substance remains same before and after the change, for example breaking of bottle and cutting of paper into small pieces, only the shape and size of the glass bottle and paper is changed and no new substance is formed.

Fig 7.2 Breaking of glass bottle

Fig 7.3 Cutting of paper

Fig 7.4: Crumpling of Aluminium foil

All physical changes are related to changes in physical properties such as change in size, shape, texture, volume, weight and temperature.

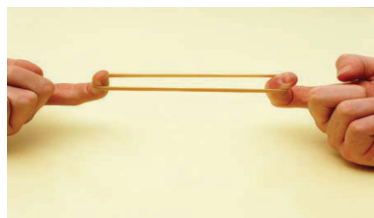



Fig 7.5 Stretching of rubber band

Physical change can be very well explained by the changes occurring in the state of water, such as melting, evaporation, freezing and condensation. (see Fig 7.6).

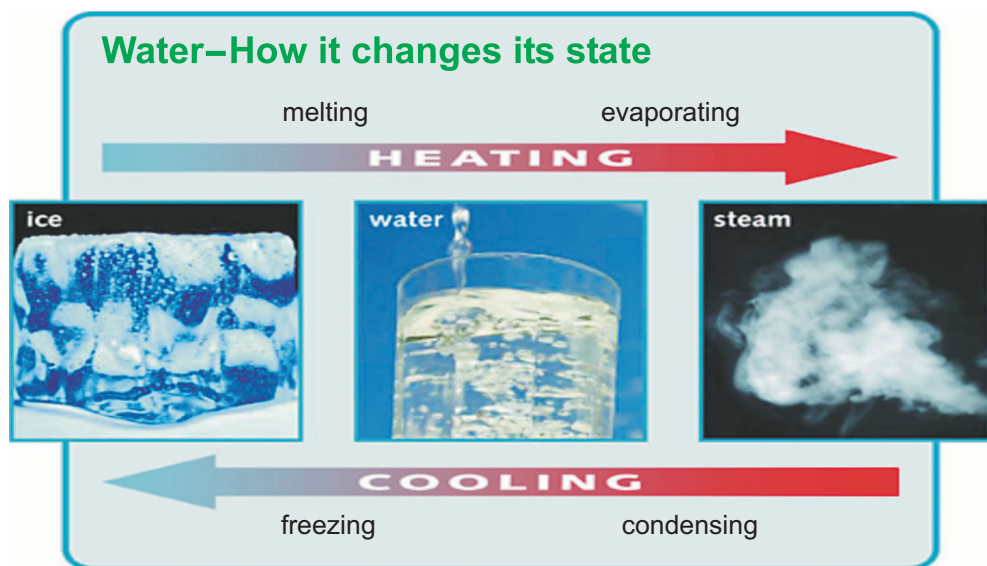



Figure 7.6: Three states of the water

Ice, water and steam are the same chemical substances in different physical states. As steam can be changed back to water on cooling and ice can be changed back to water by heating.

Is dissolving of salt in water a physical or chemical change? Can we obtain salt and water in its original form? When salt is dissolved in water, no new substances are formed. You can easily separate salt (solute) from water (solvent) by evaporation.

Figure 7.7: Dissolving salt in water

It means in a physical change, the composition of matter does not change and material keeps its original composition. The tearing and scrambling a paper, melting of chocolate or ice, boiling, breaking, moulding of clay and metals dissolving sugar and salt in water and slicing fruit, forming of frost from water vapours in the air are examples of physical changes because only appearance, colour, size, volume, shape or form, amount of heat or temperature is changed and composition remains the same. From the above examples it can be concluded that physical changes are temporary, reversible and form no new substance.

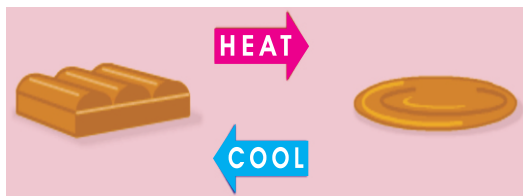



Fig 7.8 Chocolate melting in a liquid by heating and solidifying by cooling

(2) Chemical Change:

Matter can undergo chemical changes. In a chemical change a substance is transformed into a different substance with new composition. A chemical change is a process where one or more substances are changed into one or more new and different substances. You have learnt in the previous class that plants make glucose ($C_6H_{12}O_6$) from Carbon dioxide (Co_2), and water (H_2O) in the presence of sunlight. This is chemical change as glucose a new chemical substance is formed by a chemical reaction.

DO YOU KNOW?

Every time you eat something, cook or clean, several chemical changes take place. Chemical changes also take place when you take a breath, take medicine and even light a match.

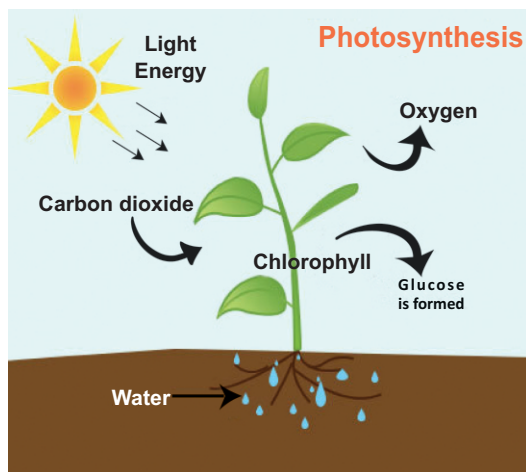



Figure 7.9: Photosynthesis

What will happen when you burn a piece of paper?

If you burn the same piece of paper which you have cut, it will form different substances such as ash and carbon dioxide, which cannot change into paper again.

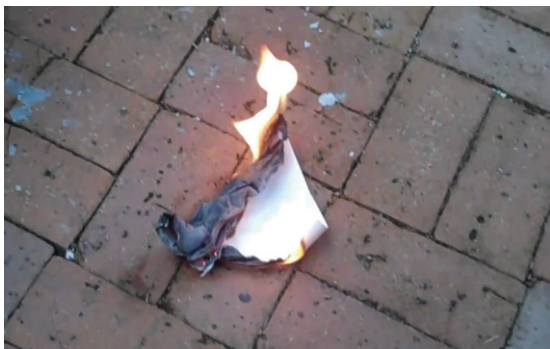



Figure 7.10: Burning of paper

Figure 7.11 Burning candle

Have you seen a burning candle, how does a burning candle undergo changes in matter and its state? Observe a burning candle, you will see the light, feel the heat and see the melting of the candle wax.

When a candle burns for a while, it eventually gets smaller. Where does the candle wax go? In the process of burning, the heat is melting the wax and changing it into liquid wax. This liquid wax will again convert into solid wax upon cooling. After some time you will smell wax gas. The liquid wax is forming wax gas. Candle wax is composed of chains of connected carbon atoms surrounded by hydrogen atoms.

Upon burning of the candle some wax is also converting into water and carbon dioxide which dissipate in the air. In this way both physical and chemical changes are taking place in the burning candle.

DO YOU KNOW?

The most popular type of candle wax used today is paraffin wax. The chemical composition of paraffin wax is commonly referred to as $C_{25}H_{52}$ (Carbon and Hydrogen). However, the actual number of carbon atoms can typically range from 22 to 27. A wax molecule is known as a long hydrocarbon with its general chemical formula being C_nH_{2n+2}, with n being a varying number of carbon atoms (22-27). Although the chemical composition of the wax is always carbon and hydrogen, the actual number of atoms will vary based on the exact origin of the wax.

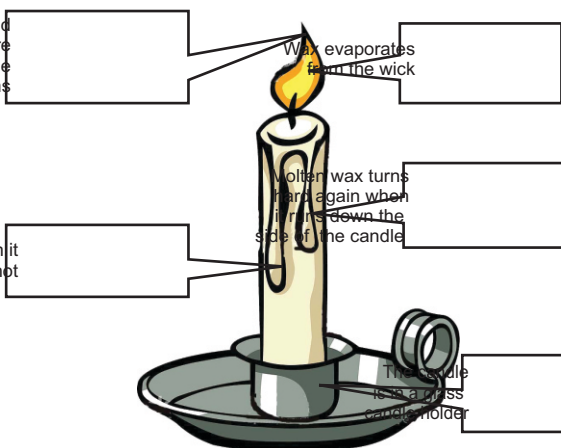



Figure 7.12

Some examples of chemical changes are burning of wood, cooking raw food, bursting of crackers, rusting of iron, digestion of food, respiration in living things and photosynthesis in plants. Chemical changes are permanent and irreversible. In order to understand chemical change, perform a simple activity of rusting of iron.

Activity 7.1: Investigating rusting of iron nail/ wire wool (work in groups of 3-5).

What I need:

- 3 small empty jars with lids/ test tubes with corks.
- Iron nails or wire wool.
- Tap water and boiled water.
- Calcium Chloride

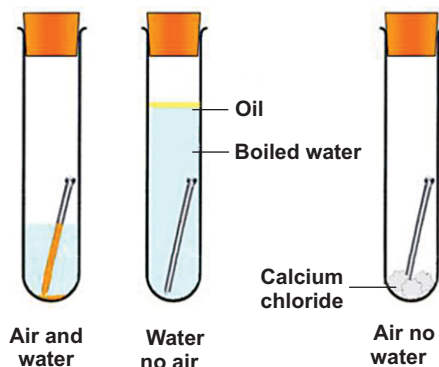



Figure 7.13

What to do:

1. Line up 3 glass jars/ test tubes and mark or label them as 1, 2, and 3.
2. Put one/two nails / a bit of wire wool in each container.
3. Pour some water into container number '1' and put the lid on it.
4. Pour some boiled water into container number '2' , add oil and put the lid on it.
5. Add Calcium Chloride in container number '3' and put the lid on.
6. After one day observe containers and write your observations of each container.

What I observed:

Container No.1: ____________________

Container No.2: ____________________

Container No.3: ____________________

Activity Questions:

In which container/test tube the rusting was happening first? Give reasons.

In which container/test tube the nails did not rust? Give reasons.

Why boiled water and oil is used in container/test tube No.2?

Why calcium chloride was added in container/test tube No.3? What will happen if calcium chloride is not added?

What I conclude:

____

____

Table7.2: Differences between physical and chemical changes

Physical Changes	Chemical Changes
• No new substances are formed. Substance/material remains same and does not lose its major properties or identity.	• New substances are formed with different properties than the parent substances.
• Generally reversible.	• Generally irreversible.
• Usually not accompanied by energy change (except in changes in states).	• Usually accompanied by energy change.
• Examples: changes in states, dissolving sugar in water, crushing a chalk into powdered form and melting of ice-cream.	• Examples: burning of fuel, rusting of iron and heating sulphur with iron fillings to produce iron sulphide.

PHYSICAL AND CHEMICAL CHANGES TAKING PLACE IN THE ENVIRONMENT

✓ Identify the physical and chemical changes taking place in environment.

✓ Identify a variety of reversible and irreversible changes in materials in their surroundings.

Many physical and chemical changes are part of our daily life. After washing the clothes we hang them to dry, all the water from clothes evaporates, which is a physical process. Cooking of breakfast,

lunch and dinner is a chemical process. Dissolving sugar in water is a physical change because no new substance is formed; water and sugar can be separated through a simple process of evaporation.

Did you observe vehicles and factories emitting toxic gasses which are the major cause of acid rain? Look at the colour of Quid-e-Azam's Mausoleum. Why white colour of marble has changed? Can you identify few more examples of physical and chemical changes taking place in the environment? Discuss in your class.

Physical and chemical changes can also be useful. Many of the life processes which take place in the body such as breathing, digestion, movement and respiration involve physical and chemical changes, without them we would not be able to survive.

DO YOU KNOW ?

Explosion of firework is a chemical change. Heat, light, sound, unpleasant gases are produced in such explosions and they can seriously harm you.

A change in which one or more new substances are formed is called a chemical change. A chemical change is also called a chemical reaction.

HYDROCARBON

✓ Explain the use of hydrocarbons as fuel.

Hydrocarbons are compounds made up of hydrogen and carbon, which are one of the types of organic compounds. Organic compounds are the compounds of carbon. Simplest hydrocarbon is methane CH_4 (natural gas) or sui gas which is used in homes and industries as a fuel. Hydrocarbons such as petrol, diesel and furnace oil are used as fuels and their burning is an example of chemical change. During this process energy is produced in the form of heat, and light.

EXPLORATION

Supplies of fossil fuels are limited and are being used at alarming rate. They will not last forever. The fact we are running out of fossil fuels means that we must plan for the future. Suggest some alternatives to overcome this problem? How can we make the best possible use of the energy we get from the fossil fuels?

Activity 7.2: Investigate the melting of wax.
What happens when you melt wax?
Is the change reversible? What type of change is this?

Chemical changes are very important in our lives. All new substances are formed as a result of chemical changes. For example, useful new materials, such as chemical fertilizers, vegetable ghee, plastics and detergents, are produced by chemical reactions. Indeed, every new material is discovered by studying chemical changes.

INVESTIGATE
Heat can bring about chemical reactions and chemical reactions may produce heat. Is this also true for light and electricity?

FERTILIZERS

✓ Explain the physical and chemical properties of fertilizers, which make them useful in agriculture.

The substances that are added in the soil to make up any deficiency of nutrients are called fertilizers. Fertilizers are very important for growing crops; they release nutrients into the soil, as they contain required chemicals. However, physical characteristics and nutrient content (chemicals) of fertilizers both are important. They determine how easily and uniformly the fertilizers spread during application. If fertilizers form lumps or dust and accumulate too much water then they are not of good quality.

Following are the physical and chemical properties of fertilizers:

1. Particle size:

Particles of different fertilizers are of different sizes. Fertilizers which have smaller particles dissolve in water faster. Thus, nutrients are quickly released. Particle sizes also affect application and storage of the fertilizer. Hard particles are better than soft particles because they release nutrients gradually.

2. Density:

Density depends on how closely packed the particles are? A low density fertilizer will take up more space than the same weight of a high density one.

3. Granule hardness:

Fertilizer particles need to be hard enough to with stand the pressure of handling and storing them. Granule hardness will depend on the chemical composition of the fertilizer as well as its other physical properties such as the shape of the particles and how much moisture they contain.

4. Moisture content:

Most fertilizers absorb water to a certain extent. However, if they take in too much water, it can be problematic. Moisture absorption depends on the chemical composition of the fertilizer, environmental conditions and the shape and size of the particles. Granules with larger surface area absorb relatively more water.

Chemical Properties of Fertilizers:

Plants have various nutrient needs, depending upon the species, the age, and location of the plant. They need sixteen nutrients for healthy growth. The major nutrients are calcium, magnesium, potassium, carbon, phosphorus, sulphur, hydrogen, nitrogen and oxygen. Addition of these nutrients for the proper growth of crops is called soil maintenance. Mostly, fertilizers are made from carbon, hydrogen and oxygen, few other elements are also involved like: phosphorus, nitrogen, potassium, calcium, sulphur etc.

Table 7.3 shows some common fertilizers.

Name of Fertilizer	Chemical Formula	Name of Fertilizer	Chemical Formula
Ammonium Nitrate	NH_4NO_3	Ammonium Sulphate	$(NH_4)_2SO_4$
Ammonium Phosphate	$(NH_4)_3\ PO_4$	Sodium Nitrate	$NaNO_3$
		Potassium Nitrate	KNO_3
Calcium Nitrate	$Ca(NO_3)_2$	Potassium Sulphate	K_2SO_4
		Urea	$NH_2\text{-}CO\text{-}NH_2$

Table 7.3 Some Common Fertilizers

Fertilizers are produced by chemical reaction e.g. Ammonium nitrate is produced by the reaction of ammonia with nitric acid.

HARMFUL EFFECTS OF IMPROPER USE OF FERTILIZERS

✓ Discuss harmful effects of improper use of fertilizers.

Excessive fertilizers may weaken a plant, promote disease, invite pests and harming the environment. So consider plant needs carefully before applying any fertilizer.

Long term use of chemical fertilizers can be harmful to soil. Fertilizers should be used according to the amount suggested by the agricultural experts.

Excessive use of fertilizers can lead to the loss of organic material humus. The top layer of soil is fertile. It gets destroyed by excessive use of fertilizer because it becomes dry, powdery and not feasible for fertilizer. The excessive use of nitrate in the soil can raise the level of free nitrate in the fruits and crops, which is harmful to people eating them.

HYDROGENATION

✓ Describe the chemical process in which vegetable oil changes into fat.

DO YOU KNOW?

Humus is blackish brown coloured organic material formed by decaying of leaves, plants, and bodies of animals.

Chemical process which changes vegetable oil into fat is called hydrogenation. The vegetable oil, is unsaturated it can add more hydrogen to its carbon backbone. When Hydrogen is passed through vegetable oil in the presence of nickel, it converts into solid nickel. In this way unsaturated vegetable oil converts into saturated fats and become, solid. Hydrogenation process is used for changing oil into banaspti ghee. After the reaction the nickel is removed. This chemical process makes them suitable for making margarine, cakes and pastries etc.

$$\text{Vegetable oil+ Hydrogen} \xrightarrow{\text{Nickel}} \text{Fat (Banaspati Ghee)}$$

PLASTICS

✓ Describe the simple process for the manufacture of plastics.

DO YOU KNOW?

Poly means many; Mono means one and Mer means part.

Plastic is a synthetic material which can be easily shaped. These are polymers made up of many small identical molecules called monomers, all strung together chemically to form complex structures.

Plastics are polymers. Polymers are somewhere between a liquid and a solid, molding to the shape of their container, but stretchy and moldable like a solid. Plastics are usually tough and good electric insulators.
Following is the simplest method for making plastic.

Activity 7.3: Making Simple Plastic.

What I need:
- White glue.
- 2 bowls
- Water
- Borax powder (laundry detergent)
- Plastic spoon for stirring

What to do:
- Dissolve one tea spoon of borax in water in the bowl.
- Add half cup glue and half cup water in next bowl stir and mix it thoroughly.
- Now add the glue mixture to borax solution and stir slowly.
- Add a few drops of food coloring and mix it up.
- The slime/polymer will begin to form immediately. Stir as much as you can, then knead it with your hands until it becomes less sticky. If water is left in the bowl, just pour it out.
- Store the slime in a secure bag in a fridge, to avoid growing mold.
- The white glue has an ingredient called polyvinyl acetate, which is a liquid polymer.
- The slimy polymer plastic is fine to touch with your bare hands. Play with it, stretch it, mold it, make crazy shapes. It's difficult to get it to hold it's shape, but it makes a great creepy plastic alien to play with.

EXPLORATION

Observe your surroundings and make a list of 5 reversible and 5 irreversible changes happening around you. Discuss and share them with your teachers, class mates, elder sisters and brothers and parents.

Summary

- Changes in materials are of two types:
  1. Physical change
  2. Chemical change
- Physical change is a change in physical appearance or state of a substance.
- Chemical change is a change in chemical composition of a substance.
- Chemical fertilizers, banaspati ghee and plastics are the product of chemical changes.
- Physical and chemical properties of fertilizers are very important for the growth of plants because they overcome the deficiency of nutrients in the soil.
- Improper use of fertilizers can cause water pollution.
- Vegetable oil converts into banaspati ghee by the process of hydrogenation in the presence of nickel as catalyst.
- Plastics are very large molecules called polymers which are made from many smaller molecules called monomers.

Review Exercises

1. Write short answers of the following questions:

   i) Differentiate between physical and chemical changes by giving at least two examples of each.

   ii) Write three examples of physical changes and three examples of chemical changes which you have observed in your home/school or locality.

   iii) Identify the type of change:

      A) Dissolving a solid (sugar) in water.

      b) Mixing things together and

      c) Separating mixtures.

2. Give reason(s) for your answer(s).

   i) Explain the use of hydrocarbon as fuels.

   ii) Why fertilizers are used by farmers? What happens if fertilizers are used improperly?

   iii) Describe the common properties of fertilizers.

   iv) Describe the simple process of making plastic.

   v) Explain how vegetable oil changes into fat?

3. Fill in the blanks with suitable words

   i) Melting of ice cream is a ________change.

   ii) The ________change is irreversible.

   iii) Mixing of sugar in water is a ________change.

   iv) Melting of wax is a ________change.

   v) ________changes are reversible.

4. Choose the correct answer from the given choices.

i) What is produced when fuel is burned?

(a) Carbon dioxide gas (b) Methane gas (c) Oxygen gas

ii) Burning of wood is a _________change.

(a) Chemical (b) Physical (c)Temporary

iii) Oil can change into fat by___________.

(a) Evaporation (b) Fertilization (c) Hydrogenation

iv) Fertilizers are used to fulfil the ______ requirements of plants.

(a) Nutritional (b) Reproductive (c) Respiratory

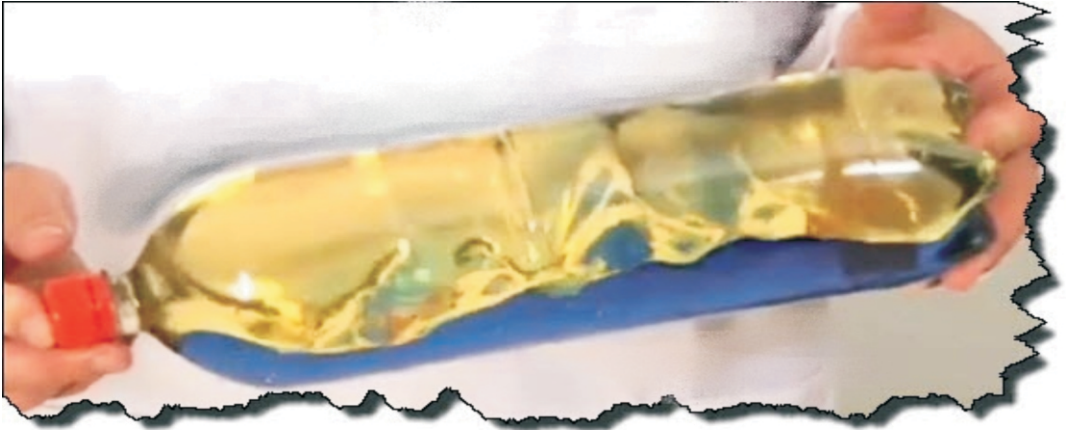
5. Identify and tick the reversible and irreversible change in the following:

Sr. No.	Statement	Reversible Change	Irreversible Change
1.	Bending of rubber		
2.	Burning of wax		
3.	Breaking of glass		
4.	Photosynthesis		
5.	Production of glucose		
6.	Water from Hydrogen and Oxygen		
7.	Conversion of ice into water		
8.	Changing of paper into ash		
9.	Boiling of an egg		
10.	A mixture of salt and sand		
11.	Glowing of electrical bulb		
12.	Dissolving sugar into water		

PROJECT

OCEAN IN A PLASTIC BOTTLE

What I need:

- Plastic bottle 1.5 litre
- Water
- Cooking oil
- Blue food-colour

What to do:

1. Take a clear plastic bottle with cap.
2. Fill 1/3rd of bottle with water.
3. Pour few drops of blue food-colouring in water and mix it well.
4. Now fill the bottle with cooking oil and place the cap tightly.
5. Hold the bottle horizontally in both the hands and shake it.
6. Observe carefully, does the movement of water resemble the movement of water in the ocean? Yes/No, Why?
7. Share and discuss your answer with the whole class.

PROJECT

MAKE THE COLOURS DANCE

What I need:

- Fresh/Full cream milk
- A small dish/ saucer
- Four different colours of food colouring
- Liquid dish wash soap
- A droper

What to do:

- Take some milk into a dish. (The more fat in the milk the more effective the results).
- Pour one drop of food colouring by the dropper anywhere on the milk, but not in the centre of the dish/saucer.
- Repeat this with the other three colours, make sure not to get the other colours too close to one another.
- Now carefully add one drop of dish washing liquid soap in the center of the milk and watch what happens.

What I observed:

Activity questions:

- Why full cream milk is used in this activity?
- What role does a drop of water play in this activity?
- Why colours start dancing?
- What chemical changes take place in this activity?

What I Conclude:

CHAPTER

8 TRANSMISSION OF HEAT

In this Chapter you will learn about:

- ➢ Transfer of Heat
- ➢ Modes of transfer of heat (Conduction, Convection and Radiation)
- ➢ Everyday applications (Conduction of heat, convection currents and radiation).
- ➢ Good and bad conductor of heat.
- ➢ Ocean currents.
- ➢ Good and bad radiators of heat.
- ➢ Good and bad absorbers of heat and vacuum flask.

All the students will be able to:

- ✓ Explain the flow of heat from hot body to cold body.
- ✓ Explain conduction, convection and radiation through experimentation.
- ✓ Recognize three modes of transfer of heat from environment.
- ✓ Suggest how birds can glide in the air for hours.
- ✓ Identify examples of appliances that make use of different modes of transfer of heat.
- ✓ List heat conducting materials in their surroundings.
- ✓ Describe the working and principle of vacuum flask.
- ✓ Explain how a vacuum flask reduces the transfer of heat.

Have you ever thought why do we feel hot during a sunny day? Do you feel hot while holding a metal spoon during cooking? Why do we see bubbles in water, while it is boiling? The answer is that heat transfers from one place to another, having different temperatures.

Modes of heat transfer in above examples are radiation, conduction and convection. Can you name the materials used to avoid heat transfer in above examples?

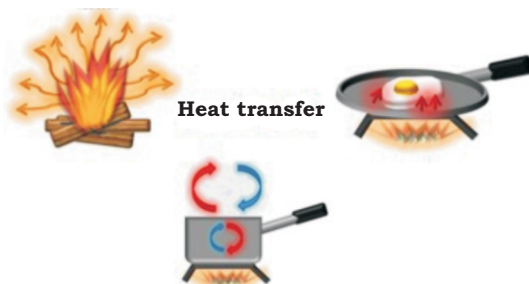



Figure 8.1 Transfer of heat

TRANSFER OF HEAT

✓ Explain the flow of heat from hot body to cold body.

As you have studied in previous classes that matter is made up of atoms and molecules, which are always in motion - either bumping into each other or vibrating back and forth. The motion of atoms and molecules results in the formation of energy called heat energy.

Often we think that heat and temperature are the same thing but you have studied in class six that, this is not the case. Heat and temperature are related to each other, but are entirely different quantities. Heat is the total energy of molecular motion in a substance while temperature is the degree of hotness or coldness measured by a definite scale. Heat energy can be transferred from one object to another, and the transfer is due to the difference in temperature between the two objects.

Activity 8.1: Investigating the transfer of heat.

What I need:

- Hot water (boiled, almost of 100°C temperature)
- Cold water at 10 to 15°C
- Three containers (beakers)
- Thermometer
- Measuring cylinder

What to do:

- First note temperatures of hot and cold water separately, with the help of thermometer.
- Take 100ml of cold water in third container and add 50ml of hot water into it and note the temperature.
- In the same container further add 50ml (total 100ml) of hot water and note the temperature.
- Again in the same container, further add 50ml (total 150ml) of hot water and note the temperature.

What I observed:

State of Water	Temperature in °C
Cold water	
Cold water 100ml + 50ml of hot water	
Cold water 100ml + 100ml of hot water	
Cold water 100ml + 150ml of hot water	

Activity Questions:

1. What was the temperature of hot water?
2. What was the temperature of cold water?
3. What was the temperature of cold water after adding 50ml of hot water?
4. Did you notice change in temperature of cold water while you kept on adding hot water into it?

What I concluded:

When two bodies of different temperatures come into contact by any means, they either lose or gain heat from each other, till both come to the same temperatures. Losing or gaining heat due to difference of temperatures in two bodies or systems is called transfer of heat. It is not necessary for the bodies to come in physical contact for transfer of heat. Heat can be transferred by other means as well, such as hot currents (in fluids) and heat waves in air and space. In the later situations, generally either the bodies or systems do not reach to the same temperature due to involvement of some other factors, for example.

MODES OF HEAT TRANSFER

✓Explain conduction, convection and radiation through experimentation.
✓Recognize three modes of transfer of heat from environment.

Heat transfers from an object of high temperature to that of a lower temperature. There are three ways in which heat is transferred from one place to another, called modes of heat transformation.

Modes of heat transformation:

- Conduction
- Convection
- Radiation

Activity 8.2: Conduction of Heat

Figure 8.2 Transfer of heat by conduction

What I need:

- Iron rod
- Candle
- Burner/spirit lamp
- Match box

What to do:

1. Mark four points on iron rod at equal distances.
2. Lit the candle and put some drops of melting candle wax on iron rod at marked points.
3. Let it cool in order to form wax balls on iron rod.
4. Now lit the burner/sprit lamp and start to heat up the iron rod from the end having wax balls.
5. It is not safe to hold the rod while heating it. Tie the rod with a string or use a clamp.
6. As you start to heat it up, note down the time.
7. As the first wax ball gets melt, note down the time and so on.
8. Calculate the interval time to melt each two balls and time to melt all the balls.

What I observed:

State of Wax Ball	Time	Difference of time to melt two balls in (sec)
Initial time		
First wax ball melts		
Second wax ball melts		
Third wax ball melts		
Fourth wax ball melts		
Total time taken to melt all the balls		

Activity Questions:

1. How much time was taken to melt all the wax balls?
2. Why did the wax balls melt?
3. What did you understand by melting of wax balls?
4. Can you name this type of transfer of heat?

What I concluded:

Conduction is one of the modes of transfer of heat. Matter is made up of atoms or molecules, very close to each other and tightly packed in solids. In solids they move around fixed positions in the form of vibration. When molecules get heat from any source, they become hot.

Molecules transfer heat to the neighbouring molecules having a less temperature, through their vibrating movements. Heat transfers from one molecule to another and so on, resulting in heat transfer from one end to another. Conduction occurs only conductor in solids.

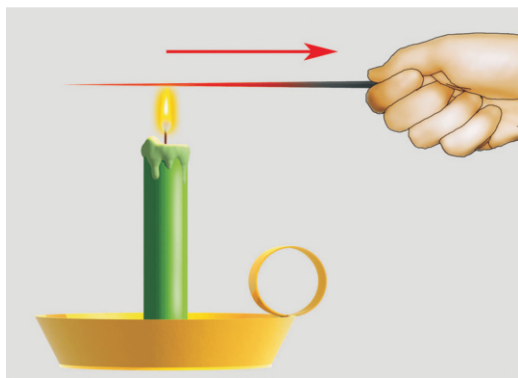



Figure 8.3 Heat transfers by conduction

Everyday application of conduction of heat:

1. When we cook something using a pot or a frying pan, we are using the pan to transfer heat from the stove to the food.
2. When we get sick and use a mercury thermometer to measure temperature, we are using the metal tip of the thermometer to transfer our body's heat to the mercury.
3. To hold a frying pan we use a wooden or plastic handle to save our hands from heat being transferred by conduction.

Teacher Note: Help students in making groups. Also instruct them to take precautions while dealing with fire and observe carefully while they take readings. Wax ball should be at the distance from first end.

GOOD AND BAD CONDUCTORS OF HEAT

We know that conduction only occurs in solids and transfers heat from high temperature to lower temperature. However, there are some solids which do not conduct heat. The solids that conduct heat are called as good conductors of heat and those which don o t conduct heat are called as bad conductors of heat or insulators. Mostly, metals are good conductors of heat. Copper is considered as the best conductor. Some materials like wood, plastic and paper etc are bad conductors of heat.

> **Think about**
> - What kind of material is used for pan to cook food?
> - How woollen clothes keep us warm in winter?

Activity 8.3: Demonstrating the convection currents in liquids.

What I need:

- Coloured beads/plastic pieces/ Paper pieces/colour pigment
- Beaker
- Water
- Wire gauze
- Tripod stand
- Burner/spirit lamp
- Match box

Figure 8.4 Transfer of heat by convection

What to do:

1. Get apparatus set in order. Put tripod stand over the spirit lamp, wire gauze on tripod stand and put beaker on wire gauze.
2. Pour water into beaker.
3. Now lit the spirit lamp and let the water boil.
4. As water is about to boil place coloured beads/plastic pieces/ paper pieces into water and observe its movement in water.

DO YOU KNOW?

Conductors	Insulators
Iron	Wood
Copper	Plastic
Silver	Wool
Mercury	Cork
Aluminium	

Teacher Note: Help the students to observe in groups or make it visible for all the students. Help them to understand the movement of coloured beads, plastic pieces, paper pieces. Instruct them to take precautions while they come closer to the apparatus.

Activity Questions:

1. What did you observe?
2. Why are the coloured beads /plastic pieces/paper pieces moving in the beaker of water?
3. How are the coloured beads /plastic pieces/paper pieces moving?

What I conclude:

Convection is another mode of heat transfer. Unlike conduction, it occurs in liquids and gases. As their molecules move freely unlike solids. Convection occurs due to the movement of fluids' molecules. When the molecules become hot at the bottom, they become lighter and rise up. Comparatively colder molecules move downwards to fill up the gaps in the bottom. In this way convection currents are formed in liquids and the same process happens in gases.

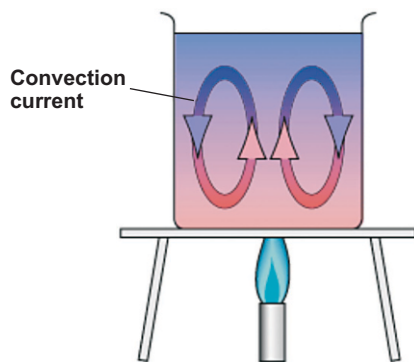



Figure 8.5 Heated water rises from the bottom to the top of the pot. Cold water replaces the rising water

EVERYDAY APPLICATION OF CONVECTION OF HEAT

1. Land and Sea Breeze:

Water and land have different heating abilities. Water takes a bit more time to warm up and is able to retain the heat for longer time than land does. Due to the convection in atmosphere, two types of breezes occur along coastal areas or areas adjacent with large water bodies.

In the day, when the sun is up, the land heats up very quickly and the air above it warms up more than that above the water. The warm air over the land becomes less dense and rise up resulting to create low pressure.

The air pressure over the water is higher with cold dense air, which moves to occupy the space created over the land. The cooler air that comes along is called sea breeze.

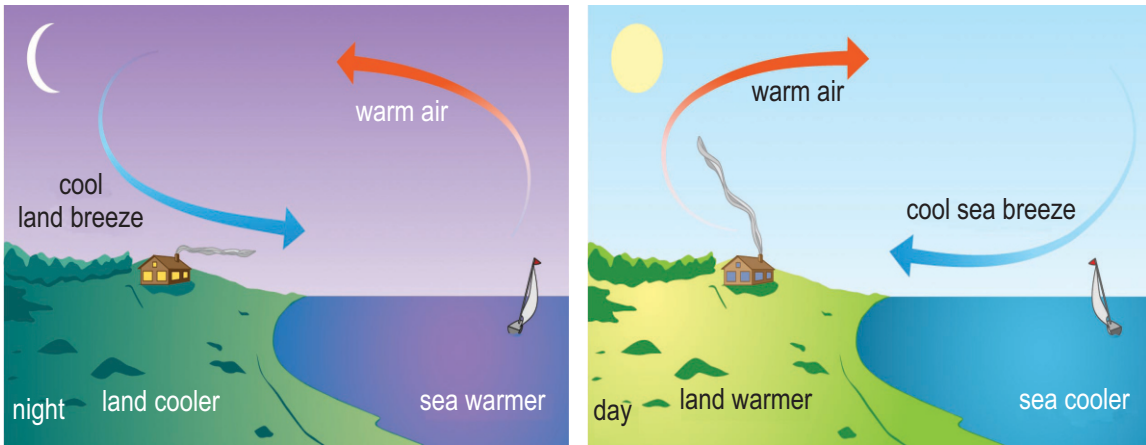



Figure 8.6 Land breeze and sea breeze

At the night, the reverse happens. The land quickly loses its' heat while water does not. This means the air over the sea water is warm, less dense and begins to rise. Low pressure is created over the sea. Cold and dense air over the land begins to move to the water surface to replace the warm rising air. The cool breeze from the land is called land breeze.

2. Ocean Currents and Winds:

Ocean currents can occur on local and global scales and are typically wind-driven, resulting in both horizontal and vertical movement of water. An ocean current is a continuous and directed movement of sea water. Ocean currents flow for great distances. Wind driven ocean currents are effected by many external factors including Earth's rotation, temperature, salinity and gravitational pull.

Global wind patterns and ocean currents determine the climate and weather of the world. Convection, which is the transfer of heat between liquids and gases, occurs between the ocean water and the air, giving the air a varying degrees of temperature and it forms climate.

Activity 8.4: Radiation of Heat

What I need:

- Tin can
- Laboratory thermometers
- Hot water

What to do:

1. Pour hot water in tin can.
2. Insert one thermometer in tin can.
3. Note down the temperature of water in the tin can after the given intervals.

Figure 8.7 Transfer of heat by radiation

What I observed:

Intervals	Temperature in °C
Initial	100 °C
After 5 minutes	
After 10 minutes	
After 15 minutes	
After 20 minutes	

Activity Questions:

1. Did you notice any change in temperature?
2. To what extent, temperature is decreased after 20 minutes?
3. What was heat transferred to?
4. Can you name this process of transfer of heat?

What I conclude:

Radiation is the transfer of heat through waves. To *radiate* means to send out or spread from the source of heat. The transfer of heat by radiation involves the carrying of heat energy from an origin to the space surrounding it. The heat is carried by waves and does not involve the movement or the interaction of matter. The hotter the object, the more it radiates. The heat received on earth from the sun is the result of radiation.

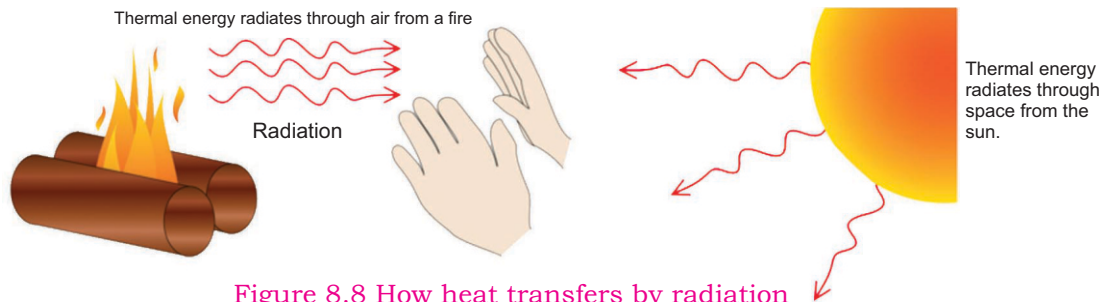



Figure 8.8 How heat transfers by radiation

GOOD AND BAD ABSORBERS AND RADIATORS OF HEAT

The rate at which an object radiates or absorbs heat by radiation depends on its temperature and nature of its surface. The hotter the object is, the more heat it radiates. Some surfaces are better radiators of heat than others. Most metals are good conductors of heat; silver and copper are exceptionally good. While the substances such as cork, wood, cotton and wool are bad conductors of heat. Dull black surfaces are good absorbers and good radiators of heat. On the other hand, shiny surfaces are poor absorbers and poor radiators of heat; they reflect the radiations away.

Everyday application of radiation of heat:

1. We receive heat from sun through radiation.
2. We feel warm in winter while sit near the fire place.
3. People of hot countries use light colours for their houses.
4. Water remains hot longer in shiny kettle as it is bad radiator of heat.
5. Shiny or white petrol tanks reflect heat from the sun and prevent petrol from heating up.

Think about

Fatima is a nature lover, she feels herself as a part of nature and enjoying all the seasons. She is always conscious about wearing dresses as per the seasons. She selects beautiful colours for her dresses that enhance her mood to enjoy nature. She always selects light colours for summers and dark colours for winter.

Can you comment that why she avoids dark colours in summers?

✓ Suggest how birds can glide in the air for hours.

The process of convection also occurs in atmosphere. In the day, when the sun is up, the land heats up very quickly and the air above it warms up a lot. Mostly in the afternoon, the warmer air near the

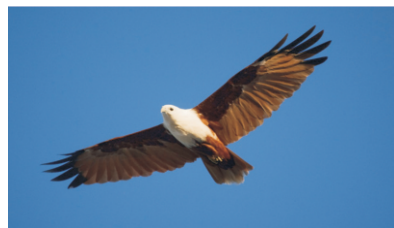



Figure 8.9 Bird is gliding in air due to thermal (Hot Air)

earth's surface expands, becoming less dense than the surrounding air. The lighter hot air rises (thermals) and get cool at higher altitude. It stops rising when it has cooled to the same temperature as the surrounding air. Birds use thermals (warm light air), their wings are useful for making use of rising warm air (due to convection).The air travels faster above the bird's wings than it does below; resulting it's flying in air.

- ✓ Identify examples of appliances that make use of different modes of transfer of heat.
- ✓ List heat conducting materials in their surroundings.

1. Refrigerator:

Refrigerator is a commonly used appliance to keep food cool to keep it for longer time. In the refrigerator, the compressor at the back, draws air through the evaporator fins to cool the food, by convection. That heat from the food is transferred into the refrigerant through the tube walls from the fins by conduction. That heat is compressed through condenser tubes and fins; transferred into the room which is carried away. There is a small amount of heat reduced by radiation. As the refrigerator needs to radiate its heat to the surroundings.

Figure 8.10 Refrigerator

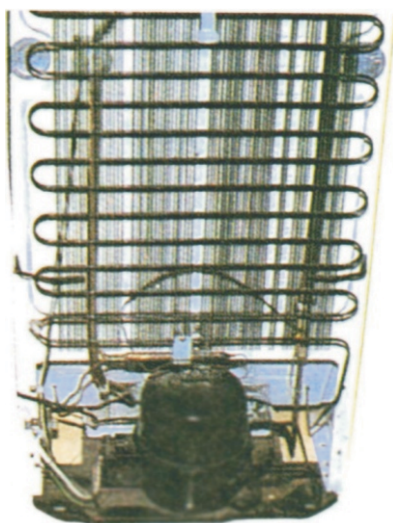



Figure 8.11 Back fins of refrigerator

2. Air Conditioner:

Air conditioners and refrigerators work the same way. Instead of cooling just the small, insulated space inside of a refrigerator, an air conditioner cools a room or a whole house.

The cooling unit of air conditioner is placed at a height inside the room. The warm air in the room rises up to the cooling unit it gets cooled thus the room gets cooled.

Figure 8.12 Air Conditioner at the top

THE VACUUM FLASK

- ✓ Describe the working and principle of vacuum flask.
- ✓ Explain how a vacuum flask reduces the transfer of heat.

The vacuum flask is a special kind of bottle in which hot liquids like tea and milk remain hot and the cold items like ice and cold water remain cold for a long time. It consists of a double walled glass bottle. These walls are silvered form inner side. The space between the walls is evacuated with the help of a vacuum pump and sealed in order to create vacuum.

Figure 8.13 Internal structure of vacuum flask

The vacuum flask is to prevent, the flow of heat to and from the bottle. We know that heat can flow from one place to another by three modes- conduction, convention and radiation.

A vacuum flask prevents the flow of heat by any of these modes. Since there is a vacuum between the walls of the bottle, which controls flow of heat by convection and conduction. Further the silvered walls stop the loss of heat by radiation. The combination of a vacuum and the silvering lining of glass greatly reduce heat transfer by conduction, convection and radiation.

As a result, hot things kept in a thermo flask or vacuum flask do not become cold and cold ones do not become hot for a long time.

Summary

- Heat is a form of energy.
- Heat can be transferred from one object to another; from high temperature to the lower temperature.
- There are three modes of heat transfer that is conduction, convection and radiation.
- Conduction does occur only in solids; metals are the good conductors of heat.
- The objects which do not conduct heat, are called bad conductors or insulators such as wood, plastic, glass etc.
- The process of convection occurs in liquids and gases.
- Heat transfering by radiation does not need any medium.
- Convection occurs in atmosphere due to which sea and land breezes are blowing. It also helps the birds to glide in air for hours easily.
- We receive sun heat through the process of radiation.
- Different colours radiate and absorb heat at different rate.
- Devices are being invented on the phenomenon of heat transfer such as refrigerator, air-conditioned etc.
- Vacuum flask is the invention most commonly used in our daily life to reduce heat transfer by any mode.

Review Exercises

1. Match the statement of column 'A' with column 'B'.

Column A	Column B
i) Degree of hotness and coldness of any object	a) White colour
ii) Best conductor of heat	b) Copper
iii) Wind driven currents	c) Radiation
iv) Transfer of heat in vacuum	d) Temperature
v) Poor radiator of heat	e) Ocean currents

2. Fill in the blanks.

   i) In the evenings cool breeze from the land to sea is called a __________.

   ii) Refrigerator works on the phenomenon of _____________ of heat transfer.

   iii) An ocean current is a continuous, directed movement of ___________.

   iv) We do receive sun heat by the process of ___________.

   v) Insulators do not _________ heat.

3. Explain why:

   i) We use vacuum flask to keep hot tea remains hot.

   ii) Conduction occurs only in metals.

   iii) Why Sun's heat does not reach the earth through conduction or convection?

4. State five application of radiation in our daily life.

PROJECT

Do all Colours Absorb Heat Better?

Leave ice cubes placed in boxes made of coloured paper (one box per colour; white, yellow, red and black) in the sun, and predict in which coloured box ice cubes melt first. Record the order and time required for the ice cubes to melt.

ACTIVITY SHEET

Name ____________________

Date ____________________

Do different colours absorb heat better than others?

Colours	Time to Melt (min)
White	
Yellow	
Red	
Black	

In which box ice cube melted first? ________________

In which box ice cube melted second? ________________

In which box ice cube melted third? ________________

In which box ice cube melted fourth? ________________

Do different colours absorb heat better than others? __________

Investigating Questions:

- Why do ice cubes melt?
- How does the sun affect ice?
- On which colour did the first ice cube completely melt? Why?
- Which colour absorbs heat the quickest in the sun?
- Which colour would be the best to help keep ice cubes from melting too quickly in the sun?

Teacher Note:

- Make enough ice cubes so that each group can have four. Try to make them the same size for experiment consistency.
- To save time, pre-cut and assemble (using tape) the coloured paper into five-sided boxes each big enough to fit an ice cube. Otherwise, have students cut, fold and tape together their own boxes.
- Gather the rest of the materials.
- Make copies of the activity sheet per group.

CHAPTER 9

DISPERSION OF LIGHT

In this chapter, we will study about some phenomena of light which are equally important as the transmission and reflection.Can you infer the phenomena, evident in the following pictures? **Hint:** there is one property of light that causes the following three phenomena.

In this Chapter you will learn about:

- Refraction
- Refraction in different mediums (glass and water)
- Laws of refraction and refractive index
- Real and apparent depth
- Critical angle (glass and water)
- Total internal reflection
- Applications: reflecting prisms, the periscope, mirages, fish eye view)
- Dispersion of light (spectrum and rainbow formation)
- Colours of light (primary and secondary colours)
- Colours of objects

All the students will be able to:

- ✓ Explain refraction of light and its causes
- ✓ Discuss the effects of refraction with examples
- ✓ List the colours of light using a prism
- ✓ Describe the dispersion of light by using a prism
- ✓ Identify different uses of light of different colours at home, school and country and explain the relationship of choice of colour to their purpose
- ✓ Define Spectrum of light
- ✓ Identify primary colours and show how they are combined to form secondary colours
- ✓ Identify a device in their surroundings that uses different combinations of colours
- ✓ Demonstrate how spinning of a rainbow results in the appearance of white disc
- ✓ Explain why an opaque or non-luminous object appears to be of certain colour

Figure 9.1: Is it a broken pencil?

Figure 9.2: Why does rainbow appear on Sky?

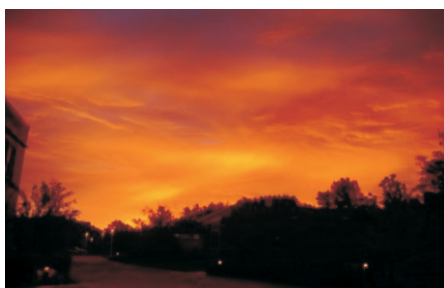



Figure 9.3: Why do the multi-coloured waves appear on Sky on Sunset?

REFRACTION OF LIGHT

✓ Explain refraction of light and its causes.

Change in the speed and direction of light rays due to change of medium is called refraction of light. When a light ray travels from a rare medium into denser medium it is refracted towards normal but when a ray of light enters into a rare medium from a denser medium it is refracted away from normal. The properties of a medium influence the behaviour of light. For instance, the density of a medium, changes both the speed and direction of light rays. The light travels fastest in the vacuum; while its speed is faster in the air as compared to the denser media such as water and glass. Moreover, the direction of light rays also changes on entering a denser medium.

Activity 9.1: Explore the refraction of light and its causes.

What I need:

Drawing board, sky blue drawing paper, a rectangular transparent glass slab, thumb tags, a torch, scissors, scotch tape and a square shaped cardboard as shown in 9.4 (a).

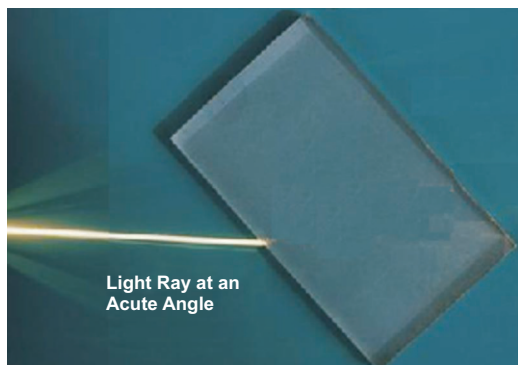



Figure 9.4 (a): Cardboard with hole

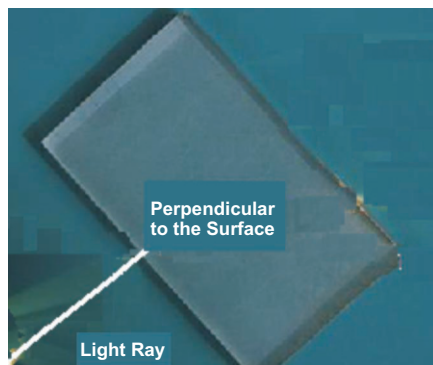



Figure 9.4 (b): Light ray at 30°/60° angle and perpendicular to the surface of glass slab

What to do:

1. Make a fine hole in the centre of the cardboard as shown in figure 9.4 (a).
2. Place a drawing board on the table.
3. Use thumb tags to fix the drawing paper on the board.
4. Fix the cardboard on a corner of the drawing board with the help of scotch tape.

5. Place the glass slab in front of the cardboard.
6. Lit torch in a way that light passes through the hole and enters the slab at (i) 30° and, (ii) 60°.
7. Use ruler and trace the path ray of light on paper.
8. Note the angles of the light ray before entering and after passing through the glass slab [(as shown in figure 9.4 (c)].
9. Repeat the process with an adjustment of the position of the slab in a way that the light ray falls perpendicular on its surface.
10. Use ruler and trace the ray of light on paper.

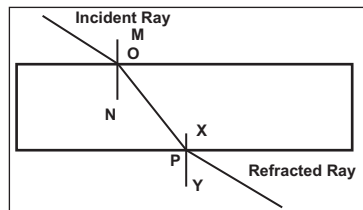



Figure 9.4 (c): Ray diagram of 30°/60°

What I observe:

For Angle 30°	For Angle 60°	Perpendicular to glass's surface
Angle, incident ray make with normal line MON =	Angle, incident ray make with normal line MON =	Angle, incident ray make with normal line MON =
Angle refracted ray make with normal line XPY =	Angle refracted ray make with normal line XPY =	Angle refracted ray make with normal line XPY =
Mention the difference (if any) in the angle of incident ray and the angle of refracted ray =	Mention the difference (if any) in the angle of incident ray and the angle of refracted ray =	Mention the difference (if any) in the angle of incident ray and the angle of refracted ray =

Activity Questions:

1. What is the direction of light ray:
   (a) When it falls at the acute angle (such as 30°/60°)?
   (b) When it falls perpendicular to the surface of glass slab?
2. What is the relation between the angle of the incident ray and the angle of refracted ray?
3. Does change in the speed of light on entering the denser medium result into refraction?
4. Does change in the angle of incident ray result into refraction irrespective of the speed of light?

Teacher Note: This is an individual activity to demonstrate the refraction of light. Ask students to follow the instructions carefully.

To sum up, when light passes from rare medium (i.e air) to the denser medium (i.e water) it bends towards normal and when light passes from denser medium (i.e water) to the rare medium (i.e air) it bends away from the normal (an imaginary line that can be drawn perpendicular to the surface of the medium such as glass or water). This bending of light is named as the refraction of light. If a light ray falls perpendicular to the surface of a denser medium such as glass and water, it changes its speed, not the direction (figure 9.4 (d).

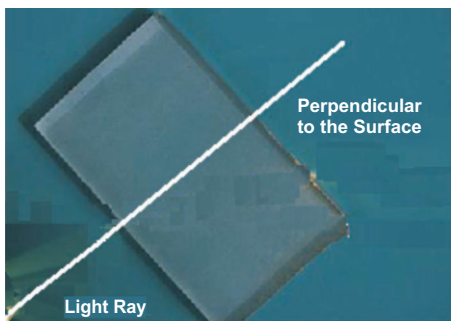



Figure 9.4 (d): No change in the direction of light

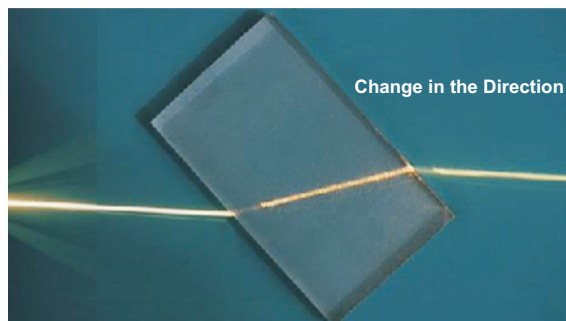



Figure 9.4 (e): Bending of light

Laws of Refraction and Refractive Index:

There are two laws of refraction.

(a) The incident ray, refracted ray and the normal at the point of incidence, all lie in the same plane.

(b) The ratio between the speed of light in vacuum and its speed in any other medium is constant. This ratio is Known as the 'Refractive Index' of that particular medium.

DO YOU KNOW?

Laws of refraction are also known the Snell's Laws, named after the scientist Willebrord Snell who discovered these laws in 1621.

Refractive Index:

The refractive index is symbolized as 'n'. It can be calculated by the following formula:

$$\text{Refractive Index (n) of a medium} = \frac{\text{Speed of light in vacuum (c)}}{\text{Speed of light in the medium (v)}}$$

It has no unit of measurement because it is a ratio. Table 9.1 shows the refractive indices of different media.

Medium	Refractive Index	Medium	Refractive Index
Vacuum	1.000	Crown Glass	1.52
Air	1.0003	Diamond	2.42
Water	1.33	Amber glass	1.55

Table 9.1: Refractive indices of different media

REFRACTION IN DIFFERENT MEDIUMS

✓ Discuss the effects of refraction with examples.

Activity 9.2: Explore the refraction of light in different mediums.

What I need:

(A transparent glass jar, cardboard, scissors, permanent marker and ruler) one set per group

What to do:

Draw an arrow (⇨)on the cardboard. Cut the cardboard into the arrow.
Measure the size of the arrow and note it down in the observation column (table 9.2).
Place the transparent glass jar on the table. Then, place the arrow behind the glass.
Observe the differences in the shape, position and size of the arrow.
Now add water in the jar and record observations in table 9.2.

	Size of arrow	Position of arrow	Shape of arrow
Before placing behind the glass			
Behind the empty glass			
Behind the glass, filled with water			

Table 9.2: Observations for refraction of light

Activity Questions:

1. How does change in the speed of light on passing through a denser medium affect the direction of light?
2. How does the change in the speed and direction of light affect the image of the object present on the other side of the:
(A) Empty glass; and (b) Glass filled with water?

Teacher Note: Divide the students into groups.
Provide one set of materials to each group and ask them to perform the experiment and observe the changes that will take place in size, shape and position of arrow.

Real and Apparent Depth:

When a light ray travels from a rare medium into a denser medium it is refracted the ray bends towards the normal. However, when the same light ray travels from a denser to the rare medium its refracted ray moves away from the normal. When this refracted light enters human eye, it makes a shallower image of the object under water. Did you observe the difference in the real and apparent depth of the bed of a swimming pool or a lake? Even, fishermen experience the same issue of having a closer vision of fish in water than its real depth.

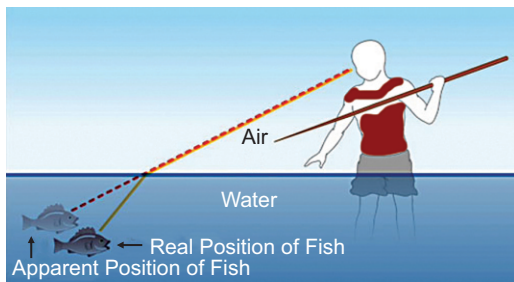



Figure 9.5: Real and apparent depth

Activity 9.3: Explore the real and apparent depth.

What I need:

Water, a wide-mouthed plastic bowl and a 5 rupee coin (one set per group).

What to do:

Take the coin and put it in the plastic bowl. Now, place the bowl on the table and one member of the group will position herself/himself in a way that coin should not be visible to her/him.

Figure 9.6: Visibility of coin and water level in the bowl

Hint
First member of the group will hold her/his position at the same height during the activity.

In the meanwhile, another group member will pour water in the bowl slowly and gradually.

Once the bowl is one-fourth filled, ask the observer if she/he can see the coin.

Pour more water to raise its level to the half of the bowl. Ask the observer if the coin is visible to her/him.

Finally, fill the bowl to its edges and ask the observer if the coin is visible to him/her.

Activity Questions	What I observed:
Is coin visible, when the bowl is one-fourth filled with water?	
Is coin visible, when the bowl is half filled?	
Is coin visible, when the bowl is filled to its edge?	
If coin is visible, give the reason for it.	

Critical Angle:

Figure 9.7 (a): Impact of Critical Angle

The angle of incidence, for which the angle of refraction is 90°, is known as the critical angle [as shown in figure 9.7 (b)]. It is denoted by 'c'. As discussed in the previous section, light rays passing through the rare medium from the denser, divert from the normal. Consequently, the angle of refraction is greater than the angle of incidence. The greater is the difference between the angles of incidence and refraction, shallower will be the image of an underwater object [as shown in figure 9.7(a)]. If the angle of incidence is increased, there will be a time when maximum refraction occurs. As a result, the angle of refraction becomes 90°. In this situation, refracted light rays become parallel to the surface of the refracting medium.

Table 9.3 shows critical angles of the different media.

Medium	Critical angle
Water	48.8°
Turpentine oil	44.1°
Crown glass	41.1°
Diamond	24.4°

Figure 9.7 (b): Critical angle

Total Internal Reflection:

As we have studied, critical angle (c) is the angle of incidence for which angle of refraction is 90°. However, when the angle of incidence is greater than the critical angle 'c', the light rays reflect back in the same denser medium. This phenomenon is named as the total internal reflection of the light rays as shown in figure 9.8 (a). There are two conditions for total internal reflection:

(i) Lights rays travel from a denser to the rare medium.

(ii) The angle of incidence of all the rays will be greater than the angle of their refraction.

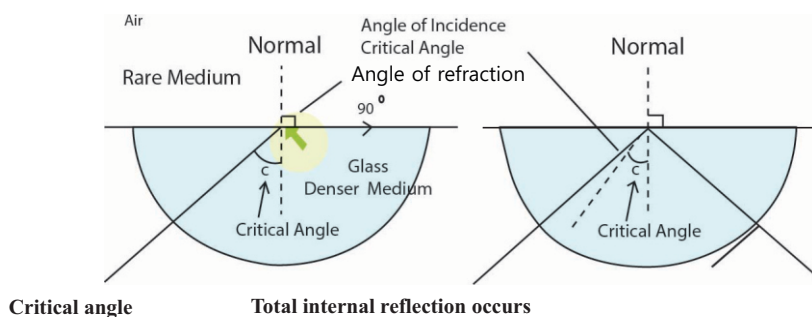



Figure 9.8 (a): Degree of C for total Internal reflection

Total internal reflection has many applications in our daily life:

(I) Reflecting prisms:

Reflecting prisms usually work on the principle of total internal reflection. Optical (visual) instruments like prismatic binocular use such prisms to invert, deviate and displace the light rays as shown in figure 9.8 (b). These prisms deviate the incident rays coming from a distant object at 180° that reforms a clear and erect image of that object. Without these prisms, object's image will appear upside down to the user of the binocular.

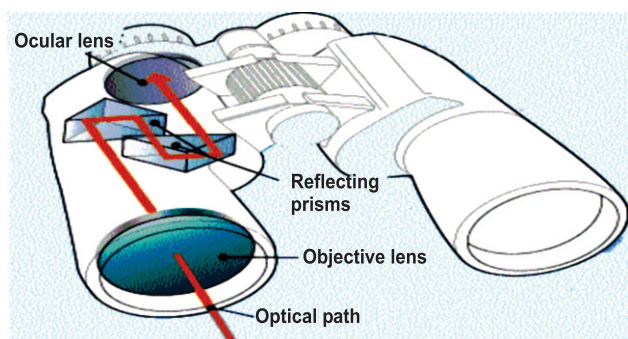



Figure 9.8 (b): Reflecting prisms

(ii) Periscope: Periscope is another optical instrument that works on the principle of total internal reflection. It has two mirrors fitted into each end of the tube at an angle of 45° in a way that they face each other. When light rays hit the top mirror at 45°, they reflect away at the same angle. As a result, the light rays bend towards the bottom mirror and make the object visible to the observer, as shown in figure 9.8 (c).

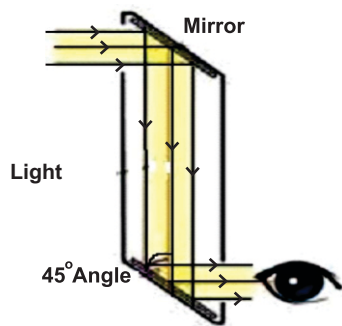



Figure 9.8 (c): Periscope

(iii) Mirage: Mirage is a phenomenon that occurs, in deserts and seas, due to which illusion of water appear away from their actual position. Mirage occurs from the refraction of light through two non-uniform mediums. Total internal reflection results in the mirage, On a hot day, a car driver may experience mirage as a puddle of water that appears on road several yards in front of his car.

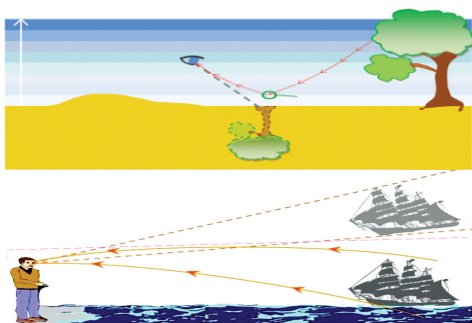



Figure 9.8 (d): Effects of total internal reflection

(Iv) Fish Eye View: Fish and other aquatic animals see a reflected view of the objects, present in their surroundings as shown in figure 9.8 (e). When light reflects from the outer world to the boundary of two non-uniform media such as air and water, total internal reflection happens. As a result, outer world objects such as the moon, sun, plants and birds are visible to the fish under water. Simultaneously, other sea animals and plants present under water and even on the seabed are visible to each other. However, the shape and the distance of the image of such objects are different from their real frame.

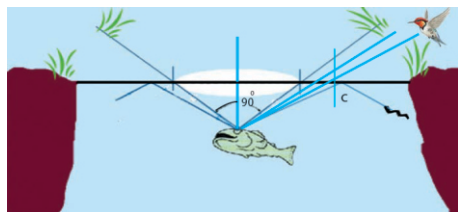



Figure 9.8 (e): Fish eye view-total internal reflection

DISPERSION OF LIGHT

✓ Describe the dispersion of light by using a prism.
✓ List colours of light using a prism. Define Spectrum.

The splitting of light into its constituent components is called dispersion of light. This phenomenon can be observed by using a dispersive prism.

DO YOU KNOW?

Triangular prism is one of the most commonly used dispersive prisms. Water droplets, water waves, dew drops and rock quartz crystals in air also act as dispersive prisms.

The seven component colours of white light are red, orange, yellow, green, blue, indigo and violet.

Activity 9.4: Demonstrate the dispersion of light by using a prism.

What I need:

A glass prism, a torch or a mobile phone light, drawing board or a table (to be used to set up the apparatus), scotch tape, a cardboard with slit in the centre, another rectangular cardboard to be used as the screen and a white sheet

What to do:

1. Wrap a white sheet around the rectangular cardboard (it will be used as the screen).
2. Set the apparatus as shown in figure 9.9.
3. Spot mobile phone or torch light on the slit of the cardboard.

Figure 9.9: Dispersion of light, apparatus setup

4. Position the prism for wide and clear spectrum of seven colours.

Note the colour stream on the screen.

Activity Questions	What I observe:
How many colours can be observed on the screen?	
What is the order of these colours, as they appear on screen?	

Spectrum and Rainbow formation:

As we have discussed earlier, a band of seven colours: red, orange, yellow, green, blue, indigo and violet appear on the dispersion of white light. This band is called the spectrum of white light. If you could recall, monsoon season and that amazing multi-coloured arch appear in the sky after rain. That mesmerising multi coloured arch is known as rainbow the best example of the spectrum of white light in nature. You can identify the order of the colours of the rainbow as of the colours of the spectrum of white light, you observed in activity 9.4.

Figure 9.10 Coloured arch-the rainbow

Activity 9.5: Demonstrate how spinning of a rainbow (spectrum) results in the appearance of the white disc.

What I need:

A white cardboard, a pencil and eraser, round lid of a tin, ruler, scissors, crayons/colour pencils of (red, orange, yellow, green, blue, indigo and violet)

Demonstrate how spinning of a rainbow results in the appearance of white disc

What to do:

1. Place cardboard on the table. Use the round lid to trace a circle on the cardboard.
2. Cut out the circle with scissors.
3. Divide the circle into seven sections and colour them.
4. Make a hole in the centre of the coloured wheel.
5. Insert the pencil in the hole.
6. Spin the wheel at different speeds and record your observation.

Figure 9.11: Colour wheel

Activity Questions	**What I observe:**
Can you see the colours, when you spin the wheel slowly?	Yes/No
If yes, then, which colour(s) could you see?	
Can you see the colours on changing the speed of wheel to its fullest?	Yes/No
If yes, then, which colour(s) could you see?	

COLOURS OF LIGHT

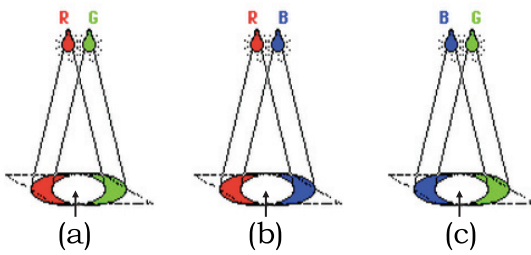
✓ Identify primary colours and show how they are combined to form secondary colours.

Although white light is composed of seven colours, still the red, green and blue are considered the primary colours of light. Can you justify the definition of primary colours?

DO YOU KNOW?

Three colours of light that produce white light on combing with the correct intensity are called primary colours of light, such as red, green and blue.

The addition of primary colours in equal intensities results in the formation of secondary colours.

Activity 9.6: Demonstrate how do the primary colours form secondary colours?

What I need:

Three colours lights (R=red, G=green and B=blue), white sheet, pencil and eraser

What to do:

Place a white sheet on the table and use the combination of any two lights as shown in figure 9.12.

Record your observations.

Activity Questions	What I observe?
Name the colour, appears on the spot (a), (b) and (c).	Figure 9.12
Are the colours on (a), (b) and (c) spots primary or secondary? Answer:	
Give the reason for your answer, if they are primary or secondary colours :	

COLOURS OF OBJECTS

- ✓ Explain why an opaque or non-luminous object appears to be of certain colour.
- ✓ Identify different uses of light of different colours at home, school and country and explain the relationship of choice of colour to their purpose.
- ✓ Identify a device in their surroundings that uses different combinations of colours.

When white light strikes on the non-luminous objects, they reflect some of its colours while absorbing all the others. Consequently, that non-luminous object appears in the colour, it reflects. For example, rose looks red when it reflects red light while absorbs all the other colours of the white light. However, there are tens of other colours of roses which can be observed in Sindh. Each rose flower has distinctive colour depends on its ability to which colour of light it reflects. Can you name the other colours of roses cultivated in Sindh?

However, when an object reflects the entire component colours of light, it appears white. In contrast, any non-luminous object appears black when it absorbs all the component colours of light. Different colours of light are used for the different purposes in our daily life. Some uses of the colours of light are given below:

1. At Home:

(i) For home decoration, both the pastel and bright colours are used. The choice of the colour of walls, curtains and the furniture depends on the weather of the area. Residents of

Karachi and Hyderabad prefer pastel colours for their houses to create the cooling and relaxing effect in the prolonged summer season.

(ii) In washrooms, toilets and other washing areas, red rims are used on the taps to show the warm water connection, while blue rims are on the taps to show the cold water supply.

2. At School:

(i) Bright colours are used to build a kindergarten school unit because bright colours create excitement and interest for learning among the young children.

(ii) Teachers use red or green colour for marking the students' assignments.

(iii) Different colour markers and chalks are used to explain different topics on the white and black or green boards respectively.

(iv) Colourful charts are used as the teaching aids to highlight different educational concepts.

3. At Country Level:

(i) Traffic light signals use red, yellow and green lights to guide the drivers and pedestrians how to behave on roads. For instance, red traffic light instructs the drivers to stop; yellow light instructs them to be cautious, while green instruct them to keep driving.

(ii) Red, yellow and orange lights and opaque objects are used to warn about the danger or cautionary actions on the public places. For instance, yellow strip indicates the edge of road for safe driving.

(iii) In building construction, white and pastel colours are used to construct hospitals because these colours give a soothing effect to the environment.

(iv) Ambulances and fire brigade use red and yellow light alarms to pass signals of emergency to other vehicle drivers.

(v) Blue light is a standard treatment for jaundice among newborn babies.

Devices like the keypads of laptops use different coloured keys for different purposes. For instance, a blue colour dot illuminates to show the connectivity of laptop with internet or Wi-Fi. It turns red when internet or Wi-Fi signals are not available.

Activity 9.7: Identifythe devices in the surroundings that use different combinations of colours.

What I need:

A pencil/pen

What to do:

Follow the teacher's instructions and act accordingly.

Make a list of devices that use different combinations of colours.

Activity Questions	What I observe:
Name the devices that use different combinations of colours.	

Teacher Note: Divide students into groups. Ask each member of the group to observe their homes, neighbourhood, school premises and close by markets for 2 days during day and evening hours.

Ask them to look for the devices that use different combinations of colours and give atleast two example.

Summary

- When light passes from a rare to the denser medium, it changes its speed and bends, this bending of light is called refraction of light.
- Refraction of light helps to form images in our eyes and assists water animals to see from inside to outside of the water. Rainbow is formed due to refraction of light.
- Refractive index is the ratio between the speed of light in vacuum and its speed in any other medium. It is a constant and can be calculated as:
- Refractive Index (n) of a medium = $\frac{\text{Speed of light in vacuum (c)}}{\text{Speed of light in the medium (v)}}$
- Critical angle (c) is the angle of incidence for which angle of refraction is 90°.
- Total internal reflection of the light occurs when the angle of the incidence of the refracted light rays is greater than the critical angle 'c'.
- Mirage and fish eye view are the two applications of the total internal reflection of light.
- Binocular and periscope also work on the principle of total internal reflection of light.
- Light on passing through a prism refracts and breaks up into its seven component colours: red, orange, yellow, green, blue, indigo and violet. This phenomenon is known as the dispersion of light.
- The band of seven colours is called spectrum.
- Rainbow is the natural spectrum, formed after the rain when droplets of water in the air serve as the prism and break white sunlight into seven colours.
- Red, blue and green are called primary colours of light. These primary colours combine in equal intensities to form the secondary colours of light.
- The colour of an opaque or non-luminous object is the colour of light it reflects. For instance, grass seems green because it reflects only green light out of the seven colours of white light.
- White objects reflect all the seven colours of light while black objects absorb all the seven colours of light.

Review Exercises

1. Fill in the blanks:
   i) When light enters a right-angled prism, it makes an angle ______________ than the critical angle.
   ii) Splitting of white light into its component colours is called_______________.
   iii) Critical angle of water is _____________.
   iv) A binocular uses ___________ prisms to see distant objects.
   v) If an object absorbs all seven colours of light, it appears in _______________ colour.
2. Describe five uses of different colours of light other than the ones stated in the chapter.
3. Draw the labelled diagrams of refraction in water and glass.
4. Compare the following:
   i) Real and apparent depth
   ii) Primary and secondary colours
5. (a) State the laws of refraction.
   (b) Discuss refractive index with the help of two examples.
6. Explain the following phenomena with the help of their labelled diagrams:
   i) Mirage
   ii) Fish eye view

PROJECT

Different phenomena of light such as reflection, refraction and dispersion have different significance in our life. These phenomena play a crucial role in the lives of humans and other animals. We can see the colours of nature and enjoy many devices that work on the principles of these three phenomena. Investigate your surroundings for a week and collect the evidence of refraction, total internal reflection and dispersion of light.

(a) Make a list of the events in which you observed refraction, total internal reflection and the dispersion of light.

(b) Find out the factors that contributed in the refraction, total internal reflection and the dispersion of light.

(c) Mention at least one incidence in which reflection, refraction and total internal reflection occur simultaneously.

(d) What will happen to our life, if refraction and dispersion of light do not happen in nature?

CHAPTER

10 SOUND WAVES

In the previous class, you have studied that sound is a form of energy that is produced by the vibrating objects. Sound needs a medium to travel from one place to another. The properties of a medium determine the audibility and quality of sound. Did you ever experience the change in the voice of your friends on the phone as compared to their voices in person?

As we know, water ripples can be produced by throwing a stone in water (as shown in figure 10.1). What cause waves? It is the vibration of water molecules that causes wave. We can define these ripples or waves as the disturbance produced by the vibration of different substances.

In this Chapter you will learn about:

- Transverse and longitudinal waves.
- Introduction to terms(wavelength, speed, amplitude and frequency)
- Pitch and loudness
- Audible frequency range
- Applications of different sounds in our daily life (doorbells, sirens, telephones, radios, stereos, smoke detectors security system alarms)

All the students will be able to:

- ✓ Explain the wavelength, frequency and amplitude of sound and give their units.
- ✓ State factors on which sound depends.
- ✓ Investigate objects in home and surroundings that are designed and made to produce different sounds.
- ✓ Compare audible frequency range of human beings and different animals.
- ✓ Design a musical instrument to explain the relation between its sound and shape.
- ✓ Identify the applications of different sounds in daily life.

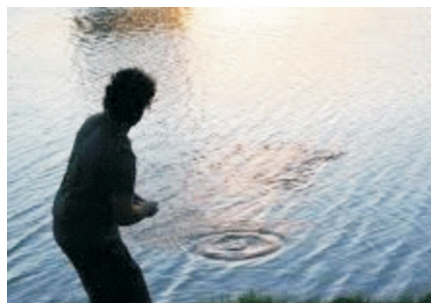



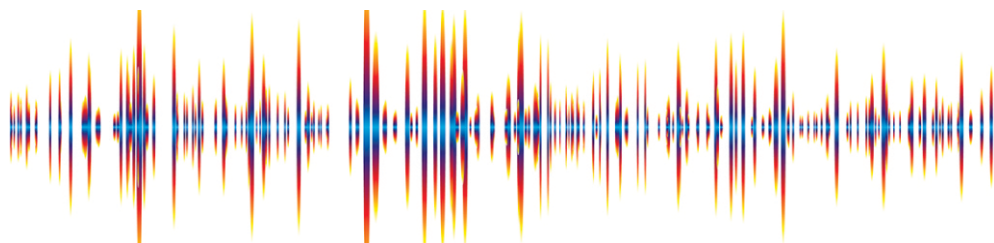
Figure 10.1: Water ripples

TRANSVERSE AND LONGITUDINAL WAVES

✓ Explain the wavelength, frequency and amplitude of sound and give their units.

Waves transfer energy from one place to another. However, different forms of energy travel through different waves. These waves have distinctive characteristics. For instance, sound waves need a medium (some material such as metals, water and air) to travel.

Figure 10.2: Sound waves

Activity 10.1: Investigate the properties of different waves.

What I need:

Two slinkies (plastic coil/spring), pencil/pen.

Figure 10.3 (a):Students holding a slinky

What to do:

Stand in front of each other and hold the slinky as shown in figure 10.3 (a).

Compress

Pair A: First, compress the slinky with full force.

Note: It will compress to the level, it sticks to other member's hand as shown in figure 10.3 (b).

Now, release the pressure on the slinky.

Figure 10.3 (b)

Pair B: Move slinky up and down with a greater speed.

Observe the movement of slinky produced by pair A and B respectively.

Take notes to answer the questions, mentioned in the observation column.

What I observed:

Figure 10.3 (c): Direction of hand movement and waves formation

- Is the vibration of slinky perpendicular or parallel to the wave propagation?
- Are there any areas of compression in the slinky?
- How many waves are produced during one movement of the slinky?

Activity Questions:

1. How many types of waves can be produced through vertical and horizontal movements of the slinky?
2. What are the characteristics of the waves shown in figure 10.3 (c)?

Waves produced by pair 'A' have areas of compression and rarefaction, and the movement of the particles in slinky seems parallel to the direction of wave propagation. In contrast, waves produced by pair 'B' have crests and troughs and the movement of particles in slinky seems perpendicular to the direction of wave propagation.

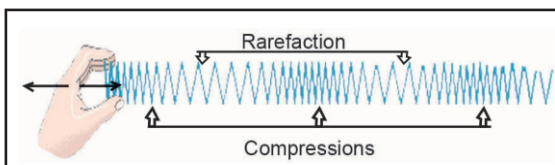



Figure 10.3(d): Longitudinal waves

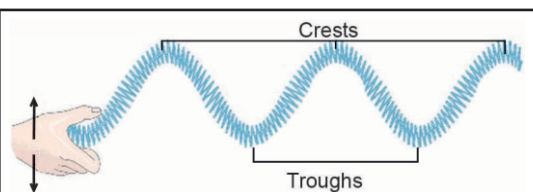



Figure 10.3 (e): Transverse waves

Waves having compressions and rarefactions (as shown in figure 10.3 d) with oscillation (movements) of particles parallel to the direction of wave propagation are named as **longitudinal waves**. Examples are seismic and sound waves. In contrast, waves having crests and troughs (as shown in figure 10.3 e) with oscillation (movements) of particles perpendicular to the direction of wave

propagation are called **transverse waves**.

In solids, sound waves are transverse waves because molecules just vibrate on their rest position and pass energy from one point to another. However, intermolecular spaces in fluids and gases allow only longitudinal sound waves to travel through them. Furthermore, the speed and audibility of sound also depend on the molecular movements of its medium.

In order to explain the characteristics of sound waves, we need to learn different terms such as:

(I) wavelength,
(ii) frequency,
(iii) amplitude and,
(iv) speed of these waves.

(i) Wavelength:

In a transverse wave, the wavelength is the distance between its two adjacent crests or troughs as shown in figure 10.4. Similarly, the wavelength is the distance between two adjacent compressions or rarefactions of a longitudinal wave. Wavelength is symbolized by the Greek letter, lambda (λ) while it is measured in metres (m).

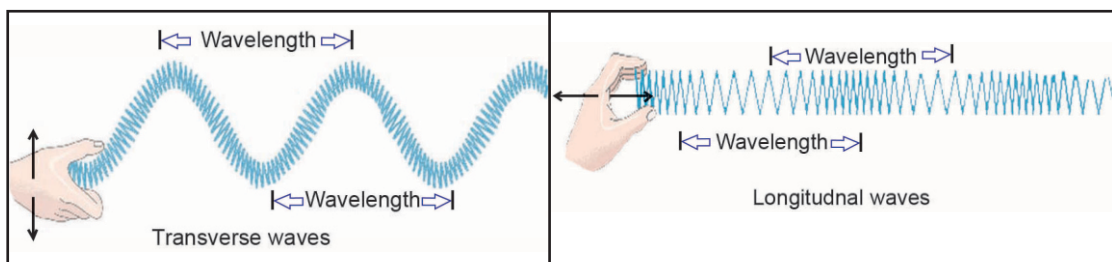



Figure 10.4: Sound waves

(ii) Amplitude:

As waves travel, the distance between the rest position of the moving particles to the top of a crest or the bottom of a trough is termed as amplitude (a). Amplitude is measured in metre (m) as well as decibel (dB) of the sound pressure. Here it is important to understand that amplitude is not the distance between the crest (top) and the trough (bottom) of a wave. The difference between amplitude (a) and wavelength (λ) is evident in figure 10.5.

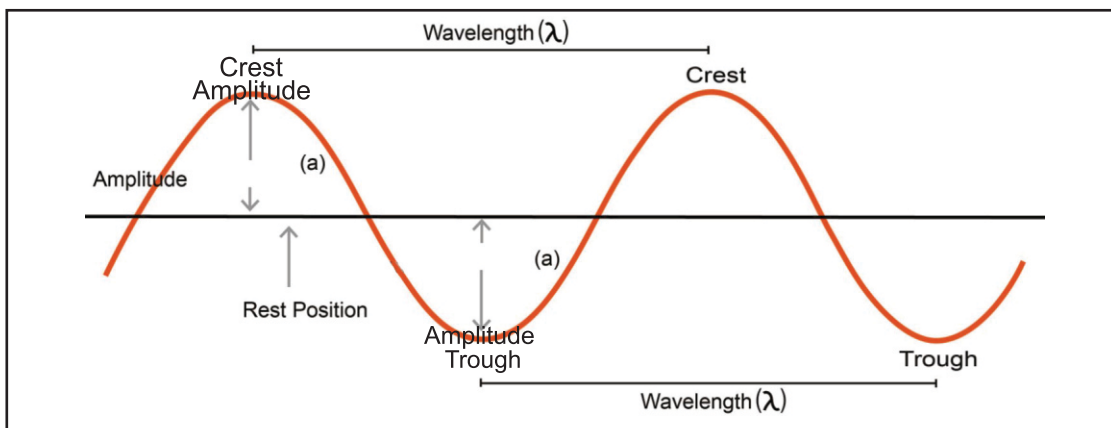



Figure 10.5: Amplitude (a) and Wavelength (**λ**)

(iii) Frequency:

The number of vibrations produced by a vibrating body in a second is called frequency (**f**). Frequency is measured in Hertz (Hz). Frequency of the sound waves can be calculated by the following formula:

Figure 10.6: Frequency of a sound wave

$$\text{Frequency (f)} = \frac{\textbf{Number of waves}}{\textbf{Time (in seconds)}}$$

For instance, when one wave passes through a point in one second, the frequency will be 1Hz (figure 10. 6). It will be mentioned as 1cycle/s. Here, 's' denotes time in seconds.

(iv) Speed:

The distance a sound wave covers in a unit of time is called its speed. Speed is measured in metre per second (m/s). Both light and sound are forms of energy that have different speed. Light waves travel faster as compared to the sound waves. The speed of sound also depends on the properties of its medium, hence sound travels at a different speed in different mediums. For instance, sound travels fastest in diamond and slowest in air. The stiffer the medium, the faster is the speed of sound.

Figure 10.6 Lightning and thunder

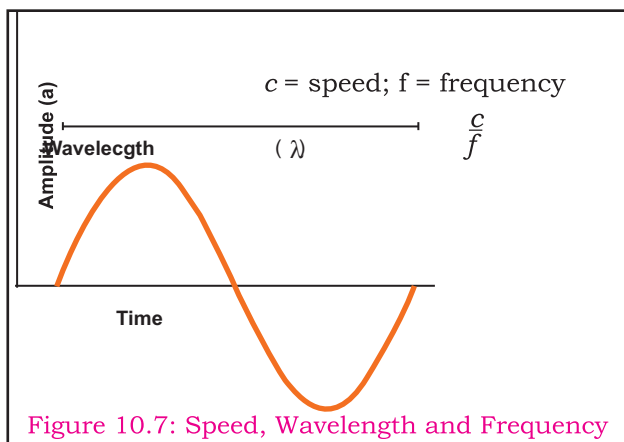
Table 10.1 shows the speed of sound in different media.

Medium	Speed	Medium	Speed
Air	343 m/s	Diamond	12000 m/s
Water	1433 m/s	Brick	4176 m/s
Steel	6100 m/s	Wood	3300-3600 m/s

RELATIONSHIP BETWEEN SPEED, WAVELENGTH AND FREQUENCY OF SOUND WAVES

✓ State factors on which sound depends

In our daily life, we come across with different types of sounds ranging from traffic noise to the melodious music. Can you find the reasons behind such a wide range of sounds we hear in our daily routine? The speed of sound is mathematically related to the wavelength and the frequency of its waves (as shown in figure 10.7).

Figure 10.7: Speed, Wavelength and Frequency

The quality of sound depends on the properties of its medium, frequency, amplitude and speed of its waves. These factors have an impact on the audibility and pleasantness of sound. Interestingly, whether it is the unpleasant and irritating noise of traffic or the melody of our national anthem, pitch and loudness are the characteristics on which these sounds depend.

PITCH AND LOUDNESS:

PITCH:

Pitch is the highness and lowness of sound that is determined by the rate of the vibrations or frequency of sound waves. As pitch is the perceptual property of sound, high frequency of sound waves results into high-pitched, (thin sound) while a low frequency of sound waves results in low pitched, (heavy sound). Females and children have a thin and delicate voice as compared to the adult males.

Activity 10.2: Explore the effect of speed, frequency and pitch of sound.

What I need:

One set of (a rectangular plastic/metallic pencil box and three rubber bands of the same length but of three visibly distinguished thicknesses), pencil/pen.

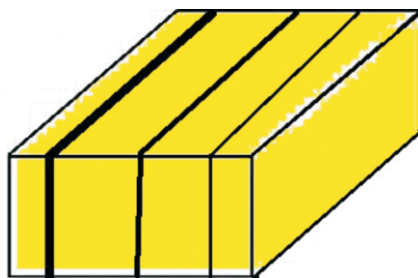



Figure 10.8 (a): Box for Activity 10.2

What to do:

Stretch each rubber band around the box as shown in figure 10.8 (a).

Mark the thinnest rubber band as 'A', middle as 'B' and the thickest as 'C'.

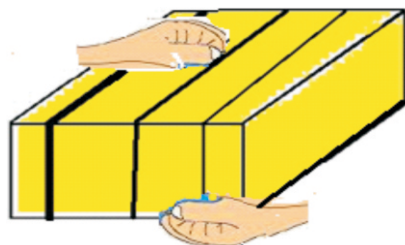



Figure 10.8 (b): How to hold the box and fret the rubber band

At first, hold the box in one hand and fret the index finger of the other hand on these rubber bands as one plays on the strings of a guitar[as shown in figure 10.8 (b)]. Increase the speed of fretting and note the variations in the pitch of the sound.

Pull each rubber band and note the variations in pitch (highness and lowness of sound).

Now, hold rubber band 'B' tightly in the middle and pull the rubber band on either side of the position, it is held. Note the pitch of the sound, produced in this act.

Change the position of your hold on the rubber to increase and decrease the length of the vibrating rubber band. Note the variations in the pitch for the difference in the length of the vibrating rubber band.

What I observed:

Activity Questions:

<table>
<tr><td rowspan="2">What does happen to the pitch of the sound as the thickness of rubber band increases?</td><td>Rubber band ‘A’</td><td>Rubber band ‘B’</td><td>Rubber band ‘C’</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td rowspan="3">What does happen to the pitch of the sound as the length of vibrating rubber band increases?</td><td colspan="3">Positions of the Vibrating rubber band 'B'</td></tr>
<tr><td>Middle</td><td>Increased</td><td>Decreased</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>What happens to the pitch of sound when the speed of fretting fingers increases?</td><td colspan="3"></td></tr>
</table>

LOUDNESS

✓ Investigate objects in home and surroundings that are designed and made to produce different sounds.

Loudness is “the degree of the sensation of sound produced in the human ear”. Loudness basically depends on the amplitude of the sound waves. However, the surface area of the source of sound and its distance from the listener also impact the loudness of the sound.

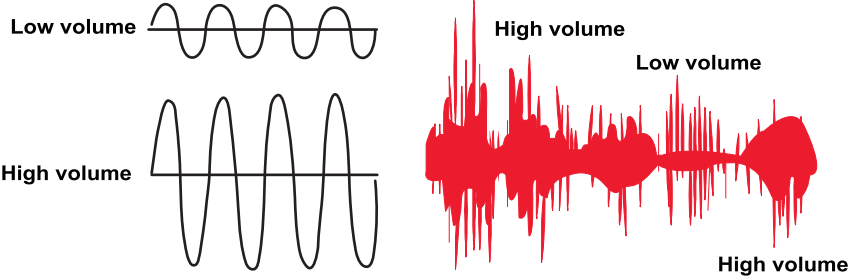



Figure 10.9: Loudness of Sound: (a) Graphics; (b) Cluster

Teacher Note: Divide students into groups and provide one set of the materials to each group. One member of each group will pull each rubber to different lengths, while other members of the group will record their observations in the above-stated columns. Make sure that rubber band should be tightly wrapped around the box.

In addition, one needs a greater amount of energy to produce louder and huskier sound. In other words, a greater amount of energy results into the higher amplitude of the sound waves which in turn increases the loudness and the intensity of the sound.

Activity 10.3: Investigate objects in home and surroundings that are designed and made to produce different sounds.

What I need:

Pencil/pen

What to do:

- Think of different sounds you heard since morning.
- Mention the source of the sound and record the observations regarding the difference in their pitch and loudness in table 10.2.

Note: Select only six different types of sounds.

<table>
<tr><th>Activity Questions</th><th colspan="3">What I observe:</th></tr>
<tr><td rowspan="2">Name the source of sound that produce different sounds.</td><td colspan="3">Mention the quality of sound and its pitch and loudness.</td></tr>
<tr><td>Thinness or heaviness of sound</td><td>Pitch of sound</td><td>Loudness of sound</td></tr>
<tr><td>School bell</td><td>Heavy</td><td>Low</td><td>Loud</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">If the sound is heavy, what can be the contributory factors for it?
Answer:</td></tr>
<tr><td colspan="4">If the sound is thin, what can be the contributory factors for it?
Answer:</td></tr>
<tr><td colspan="4">Is there any relationship between the quality of sound pitch and loudness?
Answer:</td></tr>
</table>

Table 10.2: Exploring the difference in the characteristics on which sound depends

AUDIBLE FREQUENCY RANGE

✓Compare audible frequency range of human beings and different animals

Pitch and loudness determine the quality and intensity of sound. Here, the quality and intensity of sound denote heavy or thin, loud or slow, and clearly audible sounds of different animals and humans. Can you define audible sound?

Audible sound refers to the sound that can be heard. In this way, the audible sound has a range of frequencies which can be heard by an animal or human. However, audible frequency range varies for humans and different species of animals.

Table 10.3 shows the audible frequency ranges of humans and the different species of animals.

Animal	Audible frequency range	Animals	Audible frequency range
Human	20-20,000 Hz	Cat	45-64,000 Hz
Elephant	16-20,000 Hz	Dolphin	20-120,000 Hz
Whale	10-31,000 Hz	Bat	2,000-110,000 Hz
Dog	67-45,000 Hz		

Activity 10.4: Design a musical instrument to explain the relation between its sound and shape.

What I need:

Set of (two cardboards, blue/black marker, scissor, a 12-inch ruler, scotch tape and gum stick).

What to do:

- Use a ruler to measure the length of the two cardboards.
- Use saw to cut 1inch from one end of each cardboard and save cardboard pieces to make the stoppers.
- Stopper for round flute: Use one cardboard piece to draw a circle.
- Cut around inside of the circle.
- Stopper for rectangular flute: Use another cardboard piece to draw a rectangle. Cut inside of the rectangle.
- Measure 2 inches from one end of each cardboard and mark it.

Continue the line another 0.7 inch and mark again as shown in figure 10.10 (a). This is the area where wind-way will be cut down.

Continue the line another 3 inches and mark, then 7millimetre (mm) and mark again. This 7 mm is the first hole where the first finger will be placed during playing the flute. From this point measure 0.7 inches between each 7mm area for next five holes as shown in figure 10.10(b)

Fold one cardboard into a circular way while the other into a rectangular way.

Use scotch tape to secure the circular and rectangular shapes of the flutes as shown in figure 10.10 (b).

Place round stopper inside the end of the round tube. Then, put some glue around the inner edges of the stopper and press the edges to get them stuck. Leave this tube to dry thoroughly as shown in figure 10.10 (c).

Repeat the process with the rectangular tube.

Play flute one by one and note the difference between the sounds produced by these two flutes in table 10.4.

Figure 10.10 (a): How to make wind-way

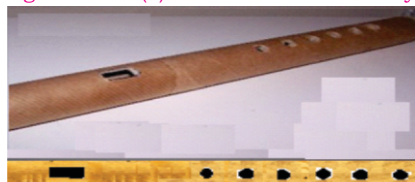



Figure 10.10 (b): How to make Marks

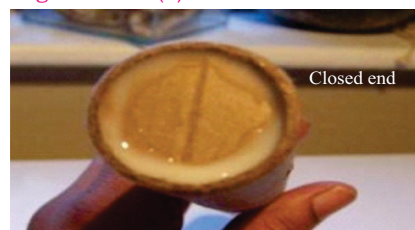



Figure 10.10 (c): How to close one end of the round tube (flute)

What I observe:

Table 10.4: Exploring the relation between the shape of the musical instrument and its sound.

Source of sound	difference in the quality of sound
Flute (round tube)	
Flute (rectangular tube)	

Activity Questions:

1. How does the shape of the flute affect the quality of its sound?
2. Enlist the differences in the quality of sound, produced by the two flutes.
3. Which flute makes the highest pitch?
4. Which flute makes the lowest pitch?

APPLICATIONS OF DIFFERENT SOUNDS

✓ Identify the applications of different sounds in daily life.

Sound as a form of energy has multiple applications in our daily life. Ranging from the ultra sonic sound to the infrasound, all frequencies of sound have distinctive benefits for humans. Sounds are used for the safety and security; treatment and detection of different diseases; telecommunications and entertainment of humans in their daily life. For example horn, Azan, bell, traffic, announcement and findings.

Sound waves in routine practices:

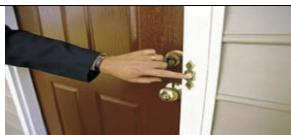



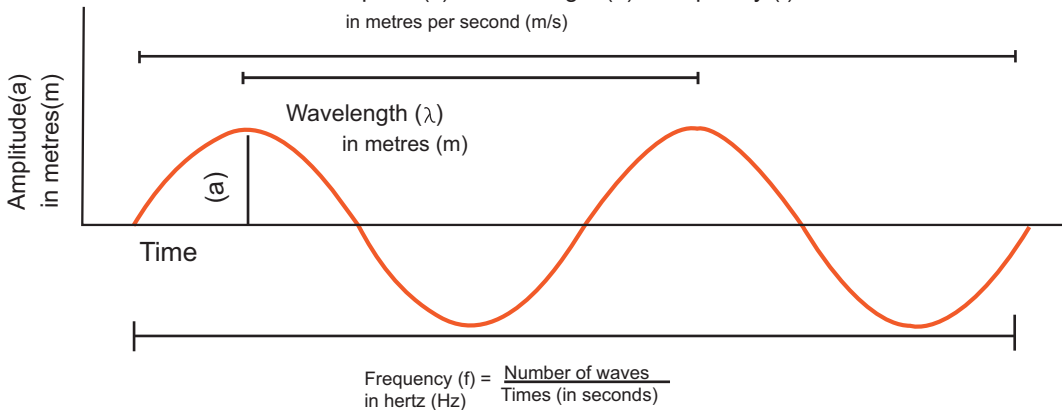
Figure 10.11 (a): Doorbell	Figure 10.11 (b): Home security alarm
The sound of doorbell indicates the presence of someone on the other side of the door.	The sound of home security alarm attracts the attention of its residents to the danger.
Figure 10.11 (c): Smoke detector	Figure 10.11 (d): Mobile phone
The alarming beep of smoke detector attracts our attention to the source of the smoke for safety and security reasons.	The sound of mobile phone attracts our attention to the distant call.
Figure 10.11 (e): Siren	Figure 10.11 (f): Parking sensor system
Siren is used at multiple occasions to attract people for different reasons. For instance, it is used to warn us about incoming danger.	Parking sensor system uses ultrasonic detectors that produce loud sound waves on the collision of any object with the car. This system warns the driver about the distance and direction of the object that hits her/his car.
Figure 10.11 (g): Music system	Figure 10.11 (h): Radio
Music system entertains us through playing music at adjustable volumes.	Radio is used for the transmission of sounds (voice and music).

Summary

Sound waves are **transverse waves** in solids.

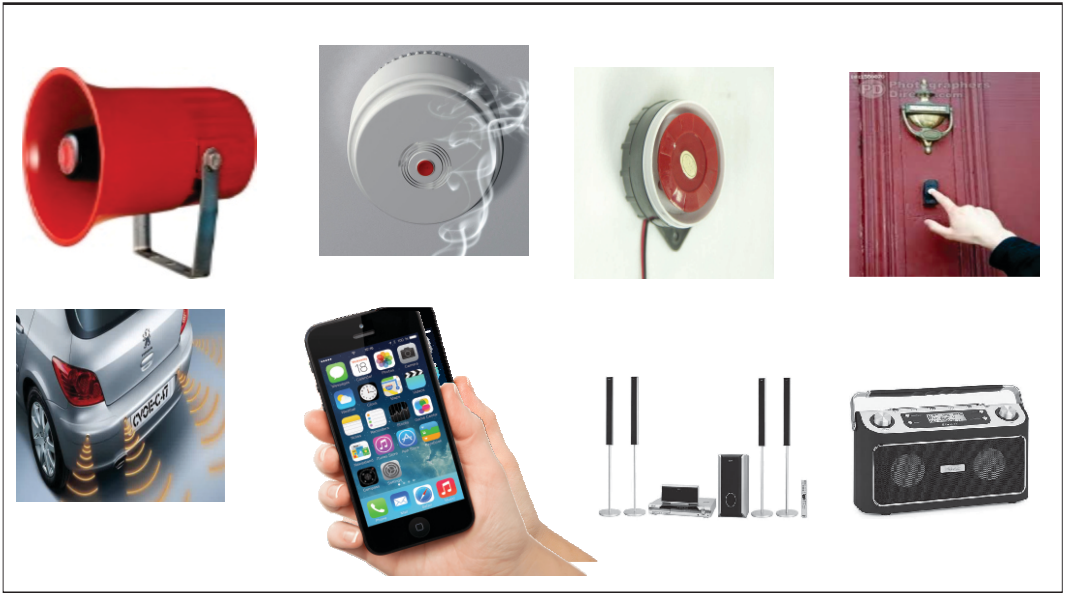
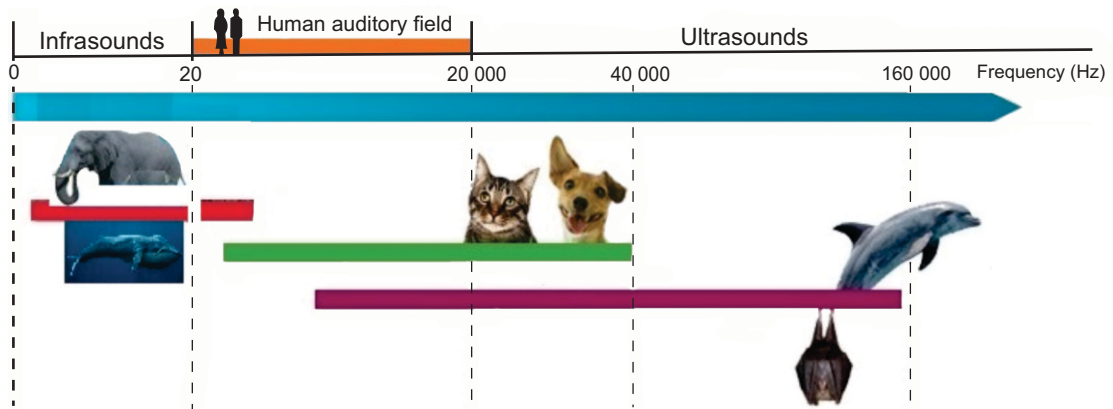
Sounds waves are **longitudinal waves** in liquids and gases.

Terms to explain Sound Waves and their Attributes

$$\text{Frequency (f) in hertz (Hz)} = \frac{\text{Number of waves}}{\text{Times (in seconds)}}$$

Pitch and loudness are the characteristics of sound

Pitch is the highness and lowness of sound.

Loudness is the degree of the sensation of sound produced in the human ear.

Applications of Sound

Audible Frequency ranges of Human and Animals Sound:

Review Exercises

1. Circle the most appropriate option:

a) Sound waves travel in solvents through ______________.

(i) transverse waves (ii) longitudinal waves

(iii) Both the transverse and longitudinal waves

b) Wavelength is symbolised as________________.

(i) ν (ii) λ (iii) δ

c) A normal human ear can hear sounds of the frequency ranges_____________.

(i) 6-20,000 Hz. (ii) 20-20,000 Hz. (iii) 20-3,000 Hz.

d) Sound travels fastest in the ____________.

(i) air (ii) water (iii) wood

e) Decibel is the unit of measurement of ______________.

(i) pitch (ii) amplitude (iii) wavelength

2. Explain the factors that impact the quality and intensity of sound.

3. Describe five ways in which sound is important for humans.

4. Given to the sound frequency ranges, identify the audible frequency ranges to a young woman, an old man, bats, cats, whale, dogs, dolphins and elephants:

Sound Frequency Ranges	Audible Frequency Ranges to
20-15,000 Hz	
2,000-110,000 Hz	
20-120,000 Hz	
45-64000 Hz	

PROJECT

Knowledge

Quality, intensity and audibility of sound depend on the wavelength, amplitude, frequency and speed of its waves. In addition, a musical instrument's shape also affects the quality and intensity of its music (sound). Like the flute, lab-based xylophone also demonstrates the relation between the quality and intensity of sound.

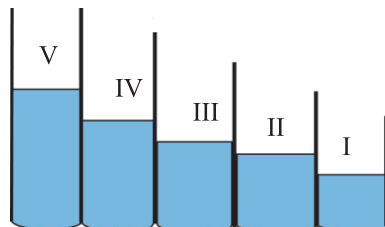
Let us make a simple xylophone to demonstrate the relation between the quality of sound and the shape of the source of sound!

Apparatus and Materials required:

- Five 1-litre water bottles/plastic jars with flat bottom and wide mouth
- Cutter
- One inch wide scotch tape
- Metal spoon
- 3 litres water
- Measuring cylinder

Figure P1

Procedure:

1. Cut bottles/jars into five sizes in a way that two adjacent bottles must have a 1-inch difference in their heights.
2. Mark these bottles/jars as I, II, III, IV and V.
3. Tie all bottles as shown in figure P1.
4. Fill bottle/jar V with 400 ml; bottle/jar IV with 350 ml; bottle/jar III with 250 ml; bottle/jar II with 200 ml; and bottle/jar I with 100 ml.
5. Tap spoon on the edges of bottles/jars in the following order: IV, II, V, I and III. Keep changing the given order to enjoy the different musical rhythms.
6. Record the difference in musical notes of all the different orders.

Activity Question:

Explain the relation between the shape of xylophone and its musical notes.

Way Forward!

Can you make a xylophone with wooden blocks and explain the relation between its shape and sound?

CHAPTER 11 CIRCUITS AND ELECTRIC CURRENT

As you know that electricity is one of the sources of energy. Electricity has become the basic need of today's life. Think about life without electricity?

In this Chapter you will learn about:

- Flow of current (direction).
- Types of electric circuits (parallel and series circuits).
- Energy transfer in an electric circuit.
- Effects of an electric current (heating, chemical, magnetic effects).
- Safety precautions: fuses and earth, the three pin plug, household circuits, KW hour and charges for electricity.
- Measuring current voltage and resistance (ammeter, voltmeter and resistors).
- Electricity at home.
- Electricity and safety (MCB, ELCB, earth wires)

All the students will be able to:

- ✓ Define current.
- ✓ Make parallel and series circuits.
- ✓ Investigate about types of circuits used for different purposes.
- ✓ Identify a disadvantage of a series circuit.
- ✓ Differentiate between current and energy.
- ✓ Explain the effects of electric current in daily use appliances.
- ✓ Describe voltage.
- ✓ Explain the resistance as an opposition to the flow of current.
- ✓ Describe the relationship between voltage and resistance.
- ✓ Measure current by using different devices.
- ✓ List the major uses of electricity in home.
- ✓ List Electrical hazards and precautionary measures to ensure the safe use of electricity at home.
- ✓ Describe why electricity is dangerous to humans.

Figure 11.1 Electrical Toaster

Figure 11.2 Electrical wires

Figure 11.3 LCD Display Monitor, TV

CURRENT

✓ Define current

The rate of flow of charge at certain point is called current.

Figure 11.4 Electric current flows from one pole to the other of an electrical source

Electrons of outermost shells of a conductor are capable of electricity flow. The electrons that have been knocked out of the outermost shell of an atom are known as free electrons. The movement of these free electrons constitutes an electric current which is the flow of electric charges. Electric current is measured in amperes (A). It is the amount of charge passing the given point in one second.

TYPES OF ELECTRIC CIRCUITS

✓ Make parallel and series circuits.

There are two main types of electric circuits, i.e. series circuits and parallel circuits.

1. Series Circuits:

If all the components are connected one after another in a single loop, then it is a series circuit. Current flows through a single path in a series circuit (figure 11.5). In this type of circuit, the amount of current which flows through each component (bulb) is the same.

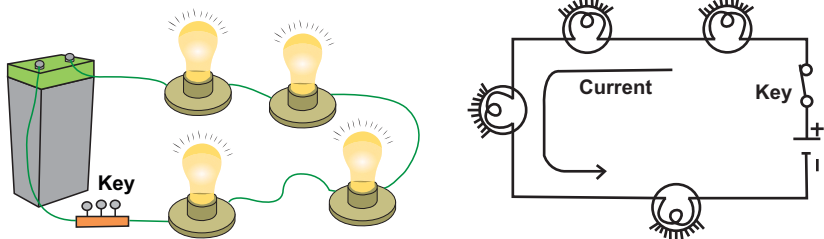



Figure 11.5 A series circuit provides only one path for the flow of current

Activity 11.1: Make a series circuit

What I need:

- Insulated wire (15 cm long 6 pieces).
- A 4.5 volt battery.
- 4.5 volt light bulbs in bulb holder (Four).
- A screw driver.
- A simple switch.

What to do:

- Connect the battery, switch and bulbs in a single loop with insulated wire as shown in the Fig 11.5.
- Add another light bulb and observe the brightness of bulbs.
- Replace one bulb with a burn out or fused bulb.

What I observed:

Activity Questions:

1. What happens to the brightness of the light bulbs when one bulb is added in the loop?
2. What happens when you replaced a light bulb with a fused bulb?

What I conclude:

2. Parallel Circuits:

If the components are connected in two or more loops, then it is a parallel circuit. Parallel circuits have more than one path for the current to flow (figure 11.6). The current flowing through different branches of a parallel circuit may be the same or different. But the current in each branch is less than the total current flowing out from the electrical source (battery).

As there is more than one path for the current to flow, a break in any branch of the circuit cuts the current-flow through that branch only.

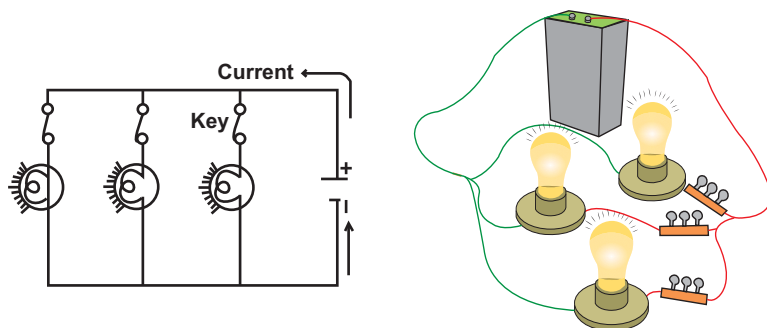



Figure 11.6 In a parallel circuit, there are more than single path for the current to flow.

Activity 11.2: Construct a parallel circuit.

What I need:

- Insulated wire (15 cm long 7 Pieces).
- A 4.5 volt battery.
- Three 4.5 volt light bulbs with bulb holder.
- A screw driver.
- A simple switch.

What to do:

1. Make a simple circuit with one bulb holder, the battery and the switch.
2. Connect a second bulb in parallel with the first bulb.
3. Add third bulb to the circuit parallel to the two bulbs.
4. Replace first bulb with a fused bulb and observe.
5. Replace the second bulb with a fused bulb and observe.

What I Observed:

Activity Questions:

1. What will happen if you unscrew one bulb from its holder?
2. Does the same thing happen if you replace one bulb with the fused bulb?

What I concluded:

USES OF CIRCUITS

✓ Investigate about types of circuits used for different purposes.

How many things around you right now use electric current? Current is used to transfer energy to many things. Each device that uses current is a part of at least one circuit, the circuit that supplies its voltage. Most electrical appliances have many circuits inside of them that are designed to carry out specific functions. Those circuits may be designed to light bulbs, move motor parts, or calculate. Each of those circuits may have thousands or even millions of parts.

DO YOU KNOW?

Thomas Edison invented the electric bulb in 1879. In 1880, he developed the first power plant to distribute the electricity in New York.

A series circuit uses a minimum amount of wire. However, a disadvantage of a series circuit is that all of the elements must be in working order for the circuit to function. The circuits in most business places and homes are connected in parallel. Look at the illustration of the kitchen and its wiring (figure 11.7). This is a parallel circuit, so even if one electrical device is switched off, the others can still be used. The circuits within many electrical devices are combinations of series

Figure 11.7 Parallel Circuit in Kitchen

circuits and parallel circuits. For example, a parallel circuit may have branches that contain several elements arranged in series.

DISADVANTAGE OF THE SERIES CIRCUIT

- ✓ Identify a disadvantage of a series circuit.

As there is only one path for the current to flow, a break at any part of the circuit stops the flow of current in the whole circuit; for example if one of the light bulbs burns out, the circuit will be broken and the other bulb will be dark, too. Series circuits have another disadvantage. Light bulbs and other resistors convert some energy into heat and light. The more light bulbs that are added to a series circuit, the less current there is available, and the dimmer all of the bulbs become.

DIFFERENCE BETWEEN CURRENT AND ENERGY

- ✓ Differentiate between current and energy.

Energy is ability to do work. It can neither be created nor be destroyed. It can be stored or transferred from one place to another or from object to object in different ways. Energy has different forms.

Electricity is one of the most useful and important forms of energy that can be transformed into many other forms of energy. Energy due to flow of electric charges within a circuit is called current electricity. We can say that current is a kind of energy.

EFFECTS OF ELECTRICAL CURRENT IN DAILY USE APPLIANCES

- ✓ Explain the effects of electric current in daily use appliances.
- ✓ List the major uses of electricity in homes.

Different devices are used for the conversion of electrical energy into other forms of energy, e.g. a light bulb transforms electrical energy to light energy. Electric bells and stereo players transform electrical energy to sound energy. A heater, hair dryer, electric iron and electrical toaster give us heat by using electrical energy while electric motors are used in a washing machine, vacuum cleaner,

electric drill and a fan which converts electrical energy into mechanical energy (figure 11.8 and 11.9).

Figure 11.8 Fan converts electrical energy into mechanical energy.

Figure 11.9 Door bell converts electrical energy into sound energy.

MEASURING CURRENT VOLTAGE AND RESISTANCE

✓Describe voltage.

Difference of potential between two points in a circuit or battery is called potential difference or voltage. Potential difference causes the charges to move through the conductor such as a wire. Charges will flow as long as there is a potential difference between the two points. Potential difference is measured in volts (V). A volt is defined as the difference of potential that carries one ampere of current against a particular quantity of resistance.

Every battery has its potential difference printed on it. For example, a dry cell carries 1.5V.

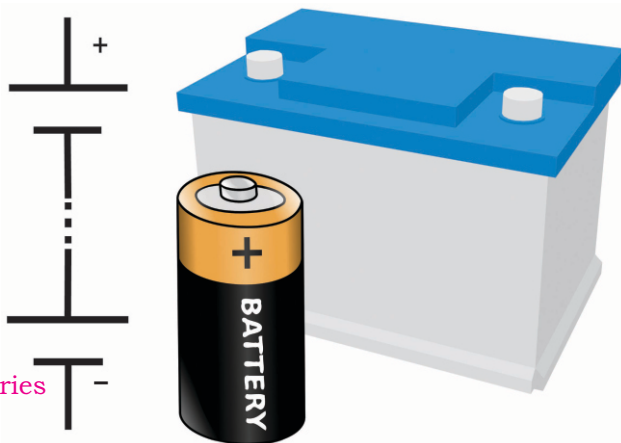



Figure 11.10 Electrical Batteries

RESISTANCE AS AN OPPOSITION TO THE FLOW OF CURRENT

✓ Explain the resistance as an opposition to the flow of current.

Electric current flows better through some materials than others. Resistance is the hindrance to the flow of current. The charges collide within the conductor (wire) numerous times, during their journey through the electric circuit. Consequently, there is the hindrance (resistance) to the flow of the current.

The resistance of a wire depends on length of the wire and thickness of the wire. Longer wires have more resistance than short wires and thin wires have more resistance than thick wires. The unit of resistance is ohm (**Ω**).

RELATIONSHIP BETWEEN VOLTAGE AND RESISTANCE

✓ Describe the relationship between voltage and resistance.

In 1827, a German scientist George Simon Ohm discovered relationship between the voltage and current in an electric circuit. It is called Ohm's Law.

The relationship between voltage and resistance is described by mathematical equation.

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}} \quad R = \frac{V}{I} \quad \text{or} \quad V = IR$$

"Current through a conductor is directly proportional to the potential difference or voltage applied across the conductor and inversely proportional to the resistance".

Resistance is a ratio of voltage to current. Above equation shows that resistance is equal to the voltage divided by the current.

MEASURING CURRENT, VOLTAGE AND RESISTANCE

✓ Measure current by using different devices.

Following devices are used to measure current, voltage and resistance of an electric circuit:

- Current — Ammeter
- Voltage — Voltmeter
- Resistance — Ohm meter

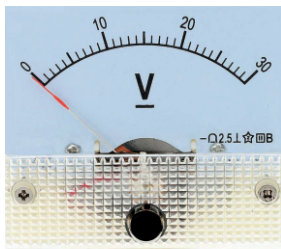



Figure 11.11 An ammeter, voltmeter and ohm meter to measure the electric current

An ammeter is the device to measure the amount of current in an electric circuit (figure.11.11). It is connected to the circuit in series so that full current passes through it. An ammeter does not change the amount of the current in a circuit because it has very low resistance.

HAZARDS OF ELECTRICITY

✓ List electrical hazards and precautionary measures to ensure the safe use of electricity at home.

✓ Describe why electricity is dangerous to human.

1. Electric shocks and electrocution:

Mostly unawareness is the main cause of electrical hazards. Following hazards cause injury or death.

- When a person touches the open plug or live wires, current flows through his body causing an electric shock to the person.
- The person is injured or may be killed.
- It can be prevented by using good quality electrical wires, that avoids its hazards.

2. Short Circuit:

- The large current flowing through the wires may cause the wire to overheat and a fire may start. Sometimes electrical sparks from a short circuit may also ignite flammable materials nearby and start a fire.
- To avoid this hazard do not connect too many electrical appliances to the same output socket.
- Do not forget to switch off an appliance as may also cause overheating of wires, which may cause a fire.

3. Safety devices:

We may safely use electricity by using following devices.

- Fuses.
- Miniature circuit breakers (MCBs)
- Earth wires.
- Three pin plug.
- Earth leakage circuit breaker (ELCB).

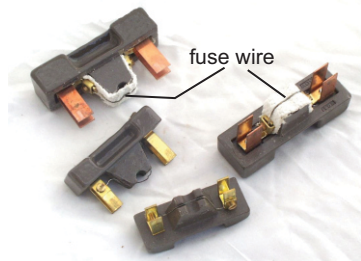



Figure 11.12 Fuses

Figure 11.13 Miniature circuit breakers (MCBs)

Figure 11.14 A Three pin plug

Figure 11.15 An earth leakage circuit breaker (ELCB)

DO YOU KNOW?

Heating effect of electricity can be dangerous. Many house and office fires have been caused by overheated faulty electrical wires or appliances.

Why is Electricity Dangerous?

Electric shock is highly dangerous and painful.

What can happen as a result?

- Muscles tighten up, making it almost impossible to pull away from the circuit.
- Lungs contract, making it hard to breathe.
- Heartbeat is interrupted and blood vessels tighten.
- Burns occur where the electricity enters and leaves the body.

This happen because the human body is a good conductor of electricity. Electricity flows easily through our bodies, because human body comprises 70 percent of water.

Secondly, that electricity always tries to find the easiest path to the ground.

If the electricity is strong enough, it can cause the victim's muscles to tighten up so much he or she can't let go.

Safety measures:

However, if you follow the following safety rules, you can use electricity without getting hurt.

1. Do not insert any metal object into electric sockets.
2. Do not touch a fallen electric wire, especially from power current lines.
3. Never touch electrical appliances with wet hands.
4. Make sure to not overload power sockets.
5. Never grab on to anyone who is shocked. Use a non-metallic object such as rubber or dry wood to shift the victim away from the electric wire.

Summary

- The movement of free electrons is called electric current.
- Electric current is measured in ampere (A).
- There are two types of circuit; series and parallel.
- The circuits in most businesses and homes are connected in parallel.
- Energy is the ability to do work and electricity is a kind of energy.
- Different household appliances are used for the conversion of electrical energy into other forms of energy.
- Potential difference between two points in a circuit is called voltage.
- Resistance is the hindrance to the flow of current.
- Safety devices can be used to prevent electricity hazards.
- Human body is good conductor of electricity, because it contains large amount of water and other liquids.

Review Exercises

1. Complete each of the following sentences by writing the correct term:

i) The circuit that provides only one path for the current is called __________.

ii) One of the unit on our electricity meter is known as________.

iii) The unit of potential difference is ________________.

iv) The unit of electric current is ________________.

v) The unit of resistance is _______________.

2. Give short answers:

i) What is an electric current?

ii) What causes the current to flow in an electrical circuit?

iii) What is the main difference between a series circuit and a parallel circuit?

iv) Is the lighting system in your classroom a parallel or series circuit? Give reason of your answer.

3. Explain hazards of electricity.

4. Suggest some ways to safe use of electricity.

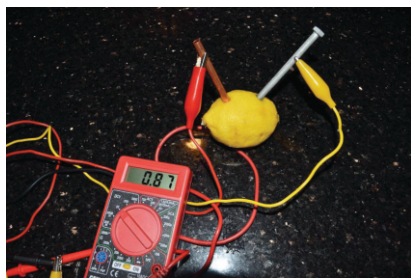
PROJECT

An electric current from lemon/potato

What I need:

- A lemon
- About 5 cm long piece of copper wire
- 1 meter long insulated wire with bare ends
- A galvanized nail
- A compass

What to do:

Press the lemon hard on a table to make it juicy inside.
- Wind the plastic coated wire round the compass several times.
- Twist one of the bare ends of wire around the copper wire
- Push the copper wire into the lemon.
- Wind the other bare end of the wire around the nail. Push the nail into the lemon, about 3 cm from the copper wire.
- Now look at the compass needle and record your observations.

Circuit with Lemon

What I observed:

Activity Questions:

- Did you observe any change? yes/ no. Give reason of your observation?
- What is the role of copper wire; the nail and the lemon juice in this activity?
- Investigate if you use potato instead of a lemon, does this make electricity too?

What I conclude:

CHAPTER 12 INVESTIGATING THE SPACE

In this Chapter you will learn about:

- What's beyond our Solar System
- Stars, Galaxies, Milky Way and Black Holes
- Star distances
- The life of Stars (The birth and death of our Sun)
- Looking at Stars

All the students will be able to:

- ✓ Explain the Big Bang Theory of the origin of the Universe.
- ✓ Evaluate the evidence that support the scientific theories of the origin of the Universe.
- ✓ Define the terms star, galaxy, milky way and black holes.
- ✓ Identify bodies in space that emit and reflect light.
- ✓ Describe a star using properties such as brightness and coluor.
- ✓ Explain the types of galaxies
- ✓ Explain the birth and death of our Sun.
- ✓ Describe the formation of black holes.
- ✓ Identify major constellations visible at night in the sky.
- ✓ Explain the working of a telescope.
- ✓ Suggest safety methods to use when observing the Sun.

Big, beautiful, barred spiral galaxy NGC 1300 lies some 70 million light-years away. . NGC 1300 spans over 100,000 light-years. It was discovered by John Herschel in 1835. This image was taken by famous Hubble Space Telescope.

WHAT'S BEYOND OUR SOLAR SYSTEM?

- ✓ Explain the Big Bang Theory of the origin of the Universe.
- ✓ Evaluate the evidence that supports the scientific theories of the origin of the Universe.

What is the universe? How did it begin? How big it is? The universe is everything we can see, touch, feel, sense, measure or detect. It includes living things, planets, stars, galaxies, dust clouds, light, and even time. It contains billions of galaxies, and each galaxy contains billions of stars. The space between the stars and galaxies is largely empty.

DO YOU KNOW?

A million is a number where there are six zeros after one like 1,000,000. One thousand counted for one thousand times is called one million. A billion is one million counted for one thousand times. There are nine zeros with one to mention in one billion like 1,000,000,000.

The scientists say that the universe was not always there. According to scientists the universe began to exist about 13.7 billion years ago. The complete size of the universe is difficult to imagine. It is so large that light from very distant objects in the universe travel billions of years before reaching Earth.

The Big Bang Theory:

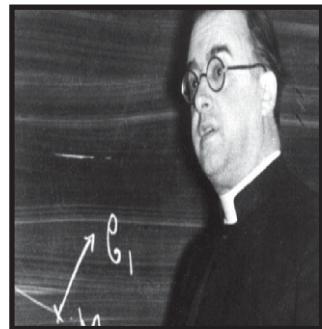
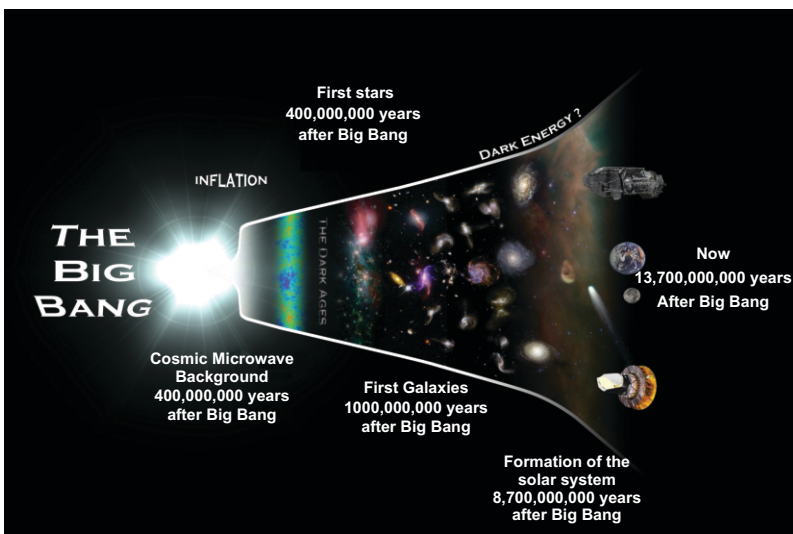
The scientific theory that describes the origin of the universe is called the Big Bang Theory. According to this theory:

"The universe began to exist as a single point, unimaginably hotter and denser than anything, and it has been expanding ever since."

Time, space and matter all began with the Big Bang. In a fraction of a second, the universe grew from smaller than a single atom to bigger than a galaxy. It is still expanding today. Due to the expansion of the universe, the conditions in the universe have changed from small to big, from hot to cold and from young to old resulting in the universe we observe today.

In 1917, Dutch astronomer Willem de Sitter used Einstein's theory to describe an expanding universe. Then Alexander Friedmann mathematically proved the idea of expanding universe. In 1920, the Belgian astronomer Georges Lemaitre concluded that if the universe were indeed expanding and has been doing as long as its existence, then there would have been a moment in the distant past when the whole universe occupied a single point. That point and the moment when the Big Bang took place would be the origin of the universe.

Georges Lemaitre

Fig 12.1: Origin of the universe according to the Big Bang Theory

DO YOU KNOW?

One of the interesting things about the universe is that it is currently expanding. It is growing larger and larger all the time. the edge of the universe is also expanding at a faster rate. Scientists say that the edge of the universe is expanding faster than the speed of light.

Evidence of the Big Bang Theory:

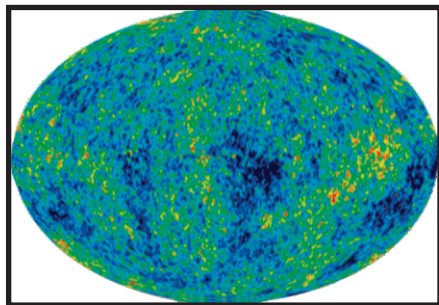
Scientists explain that due to expansion of the universe if everything is moving away from each other then it means that the universe is growing larger and larger everyday. By counting backward in time, it is possible to follow that the entire universe was just a point. It is estimated that the universe started growing and expanding about 13.7 billion years ago (age of the universe).

Another evidence supporting the Big Bang theory is the detection of the Cosmic Microwave Background (CMB) radiations.

Fig 12.2: All-sky map of CMB

CMB is said to be " the cooled leftover energy from the hot, early universe that travels freely throughout the universe and still fills space in every direction."

Scientists consider it as an echo of the Big Bang. Over the time, this light has cooled and weakened considerably; nowadays, we detect it as the microwaves.

In 1992 NASA launched the Cosmic Background Explorer (COBE) satellite. Its purpose was to study the nature of the Cosmic Microwave Background radiations. Instruments on COBE confirmed that the radiation detected by Penzias and Wilson in 1965, perfectly matches the temperature profile of the universe.

DO YOU KNOW?

Light is the fastest thing in the universe. Light travels with a speed of around three hundred millions meter per second. With this much speed it would take only a second to travel around Earth 7.5 times.

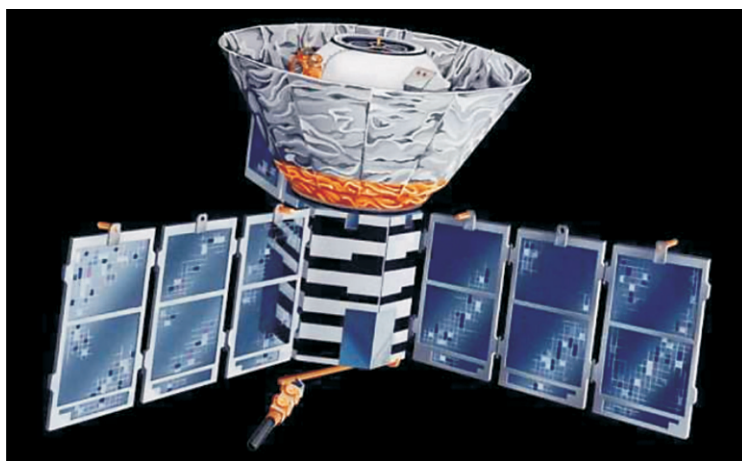



Fig 12.3: COBE Satellite

ACTIVITY 12.1 Model of Expanding Universe

- **Material / Resources Required:**

Few balloons, pencil and pages, color pencils, gum, scissors

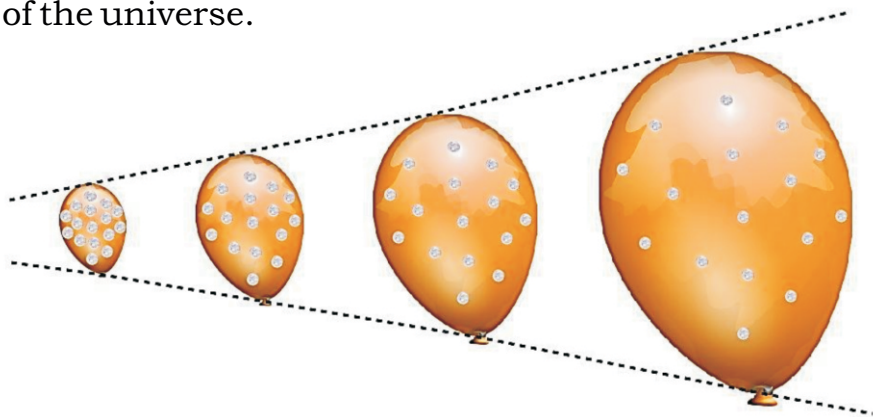
- **Procedure:**

1) Draw the following shapes in multiple on a paper.

2) Cut out all the shapes. Each shape represents a galaxy here.
3) Slowly blow up a balloon and stop as soon as the balloon appears round. Hold the end of the balloon to prevent air escaping the balloon.
4) With the help of a classmate, paste the shapes you draw earlier on the balloon at various places, covering the whole balloon.
5) Now blow up the balloon carefully until it is fully inflated.
6) As you do, observe what happens to our galaxies.
7) Make different shaped galaxies with different balloons.

Activity Questions:

1) Does a galaxy size increase as the balloon expanded?
2) What happens to the distances among the galaxies as you blow up the balloon further?

Use these observations to write about important properties of the universe.

STARS, GALAXIES AND MILKY WAY

- ✓ Define the terms star, galaxy, Milky Way.
- ✓ Identify bodies in space that emit and reflect light.
- ✓ Describe a star using properties such as brightness and colour.
- ✓ Explain the types of galaxies.

Stars:

"Stars are huge balls of gas in outer space made from hydrogen, helium and other elements producing light, heat and other forms of energy."

Our Sun is also a star and is the closest star to Earth. The next closer star to Earth is known as 'Alpha Centauri'. It is about 4.3 light years away from Earth.

On a clear night, a person can see approximately two to three thousand stars. However, with the help of binoculars or telescopes, extremely large number of stars can be observed. We see that some stars are bright in the sky, others are dim. Some look white or blue, while others look red or orange. Do you know color and brightness of stars indicate their interesting properties?

DO YOU KNOW?

Light year is a unit of distance and not the time. If one travels in a direction with the speed of light for one year (365 days), then the distance covered will be equal to one light year.

Colours of stars:

Stars appear red, orange, yellow and blue. Colours of stars are due to difference in temperature they possess. The coolest stars are the red stars and their temperature is around 3,000 degrees Celsius. The Sun has temperature of around 6,000 degrees Celsius and glows orange/yellow. The blue stars, which are the hottest, having temperature more than 25,000 degrees Celsius.

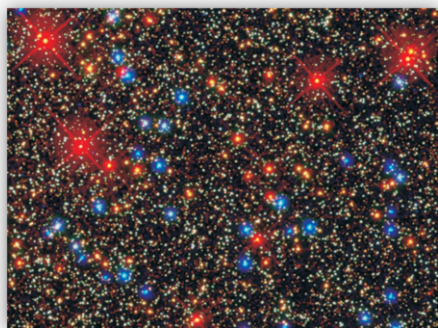



Fig 12.4: Colours of stars; blue stars are hotter than red stars

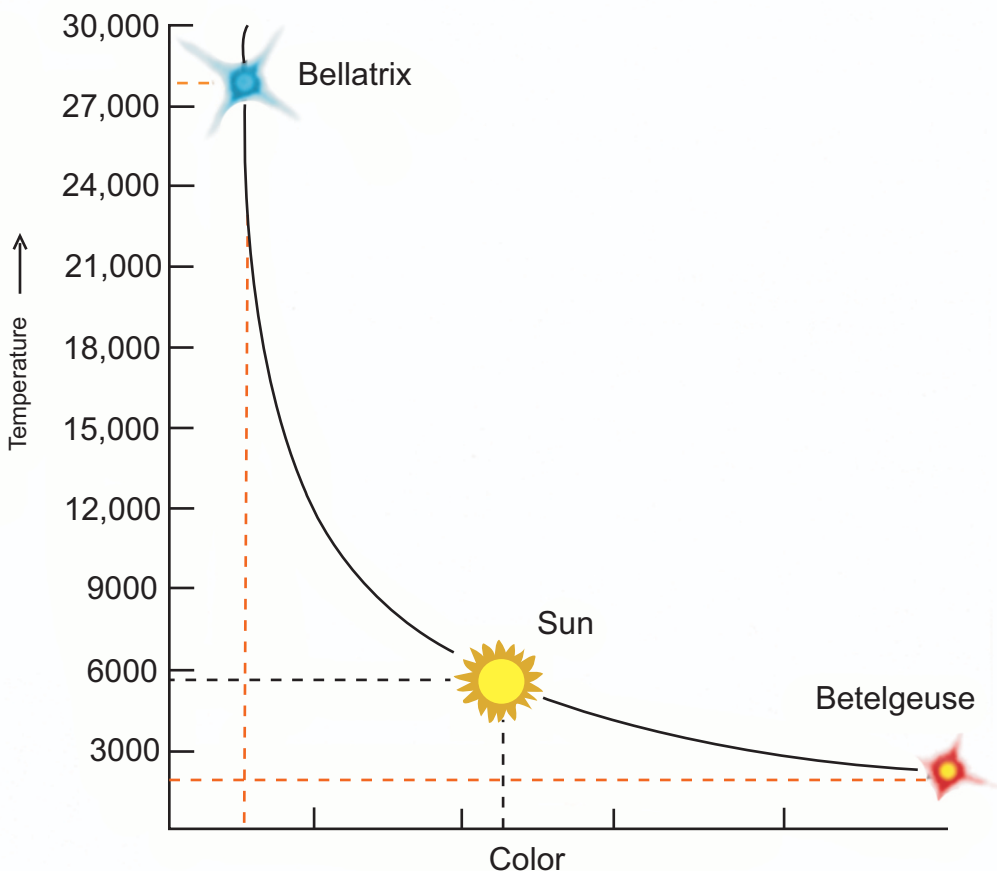



Fig 12.5: The graph showing the change in colour as the temperature of a star changes

Table below shows the colour and temperature of some brightest stars in the sky.

Colours and Temperature of Stars		
Star Name	**Color**	**Temperature (°C)**
Betelgeuse	Red	3000
Arcturus	Orange	4000
Sun	Yellow	6000
Polaris	Yellow	5800
Vega	White	10000

Brightness of stars:

Stars vary in their brightness levels as seen from Earth. A hot star gives off more energy than a cooler star. Does this then mean that a hot star is going to appear brighter than a cooler one in the sky? The answer to this depends on a few factors. These include:

The size of a star:

If two stars having the same temperature but differ in size then the larger star gives off more light than the smaller star; and will appear brighter in the sky.

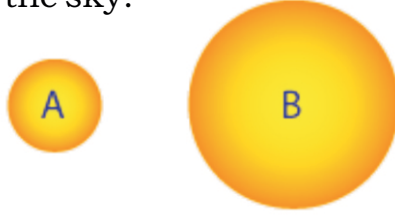



Fig 12.6: Star A and B have the same temperature.
B is bigger than A and gives off more light than A

The distance to the star:

All the stars we see in the night sky are at vast distances but some are much closer as compare to others. For two stars of the same size and temperature, the closer one will appear brighter than the star which at more distance. An analogy is a row of street lights; the closer ones appear much brighter than those at some distance.

Fig 12.7: Apparent brightness of street light changes from nearest to farthest

Intervening matter:

Space is not a perfect vacuum. Dust and gas between stars can absorb and scatter starlight leading to a reduction in brightness.

Galaxies and Their Types:

"Galaxy is a vast collection of stars, gas, dust and other forms of matter which are bound together gravitationally as a unit".

It is estimated that there are 50 to 100 billion galaxies of different shape and kind in the universe.

Each galaxy has its own identity and age. The earth is part of a galaxy, called the Milky Way.

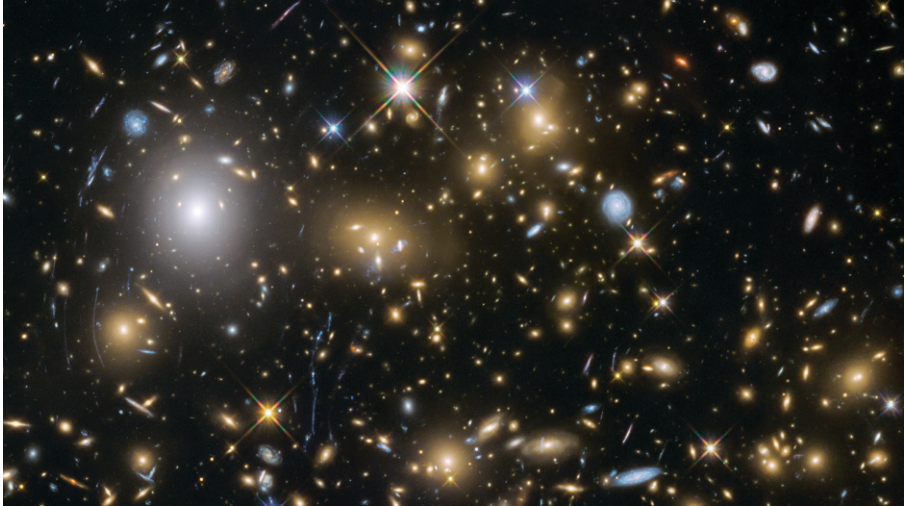



Fig 12.8: A small portion of the sky as seen through Hubble Space Telescope; every bright spot in this figure is a galaxy

Types of galaxies:

In the 1920s the pioneering astronomer Edwin Hubble, who devoted his life to studying galaxies, proposed a way to classify galaxies based on their shapes. This sequence is known as the Hubble sequence.

"According to this sequence galaxies are generally grouped by their appearance into spiral, elliptical, lenticular and irregular".

Galaxies are also often categorized by the characteristics they possess other than their appearance. For example, there are starburst galaxies, merging galaxies, active galaxies, radio galaxies and many more.

Sir Edwin Hubble

Elliptical galaxy:

An elliptical galaxy appears to be an oval shaped from our point of view as seen from the telescope. Astronomers have found that elliptical galaxies can have length, width and height that are all different from one another. Elliptical galaxies can be shaped like gigantic basketballs, ostrich eggs or anything like that. Due to their yellowish appearance, elliptical galaxies mostly contain old stars.

Fig 12.9: Two Elliptical galaxies NGC 3923 & and IC 2006

Spiral galaxy:

A spiral galaxy appears to have spiral-shaped structures or arms that contain bright young bluish stars. Spiral galaxies also have oval-shapes bulges at their centers which are filled with stars. There is also a thin disk of spinning gas surrounding the bulge; and a thinly populated halo that encloses both the disk and the bulge.

Fig 12.10: Whirpool galaxy and NGC 1566:
two beautiful spiral galaxies

Lenticular galaxy:

A lenticular galaxy is a lens-shaped galaxy that has components of both elliptical and spirals galaxies. It can be viewed as either an elliptical galaxy with a disk surrounding its outer edge, or as a spiral galaxy with a very large bulge and almost no spiral arm structure.

Fig 12.11: A lenticular galaxy

Irregular galaxy:

An irregular galaxy does not fit well into the standard categories of elliptical or spiral galaxies. Two examples of irregular galaxies are the large magellanic cloud and small magellanic cloud, which are visible from Earth's southern hemisphere.

Fig 12.12: Large magellanic cloud; an Irregular galaxy

The table below lists some of the well-known galaxies.

Some Well-Known Galaxies		
Common Name	**Catalog Name**	**Galaxy Type**
Andromeda Galaxy	Messier 31	spiral
Messier 87	NGC 4486	elliptical
Pinwheel Galaxy	Messier 101	spiral
Sombrero Galaxy	Messier 104	lenticular
Whirlpool Galaxy	Messier 51	spiral
Large and Small Magellanic Cloud	-	Irregular

The Milky Way Galaxy:

The Milky Way is the galaxy we live in. It contains the Sun and at least one hundred billion other stars. There are billions of tons of free floating clouds of gases with dust and several hundred star-clusters in milky way.

What is the shape of Milky Way? For us figuring out the shape of the Milky Way is somewhat like a fish trying to figure out the shape of the ocean. Based on observations, it appears that the Milky Way is a spiral galaxy. The disk of the Milky Way is about 100,000 light-years across and 1,000 light-years thick. Earth and the Sun are about 25,000 light-years away from the center of Milky Way. Our Solar System is moving through the Milky Way's disk in roughly circular orbit around the center of the galaxy and complete one orbit in around 250 million years.

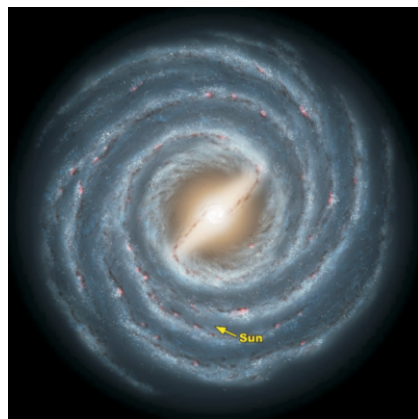
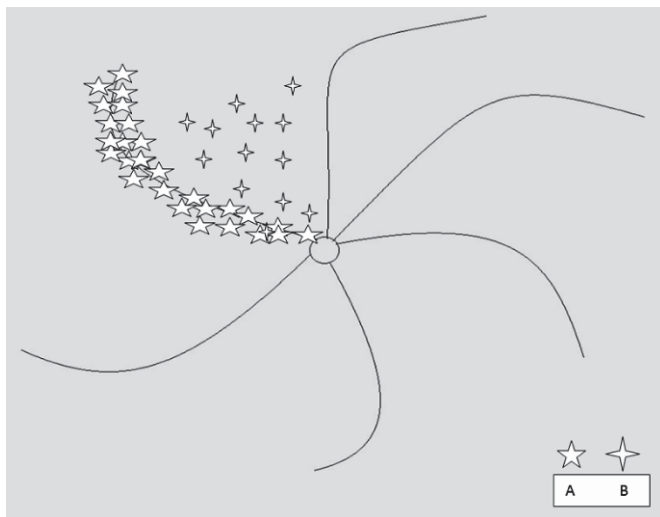



Fig 12.13: Possible shape of Milky Way galaxy; the arrow marks the position of our Sun in the galaxy

Activity 12.2 Model of Milky Way Galaxy and its different parts

- **Material / Resources Required:**
  A drawing sheet, a black sheet, color markers, pencil and pages, tissue papers, gum, glitter
- **Procedure:**

1) Mark the center of drawing sheet.
2) Make a ball of paper and paste glue over it. Now take few tissue papers and wrap the ball with it such that the tissue papers are firmly glued to the ball. Leave it to dry.
3) After it is dried, color the ball with orange and yellow markers.
4) Paste the ball at the center of the sheet you marked earlier. The ball is the center of galaxy.
5) Now take pencil and draw different spiral arms around the center of galaxy as shown below in diagram.
6) Draw and cut out lots of stars as shown below A and B. Glue A-stars to each spiral arm of the galaxy while use B-stars to fill in the gap between the arms.
7) When all the stars are firmly dried and stuck to the sheet,

8) Use blue glitter to fill in the remaining white space surrounding the spiral arms.
9) Make a small paper ball and color it yellow.
10) Paste this ball at an approximate location of the Sun as shown in the Figure 12.13. Mark the extent of the disk in light years with an arrow.

Star distances:

The determination of distances to stars is important in understanding their physical nature. Astronomers have developed a variety of clever techniques for measuring the vast distances to stars, one is called Parallax.

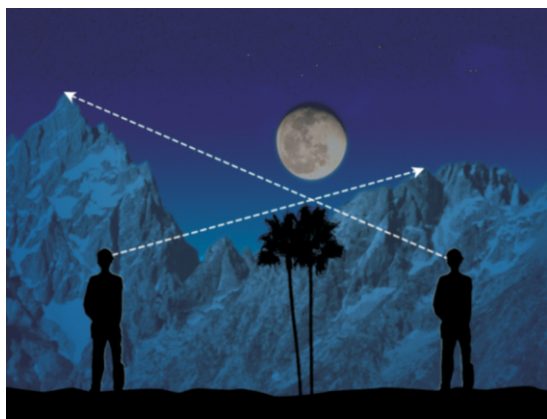
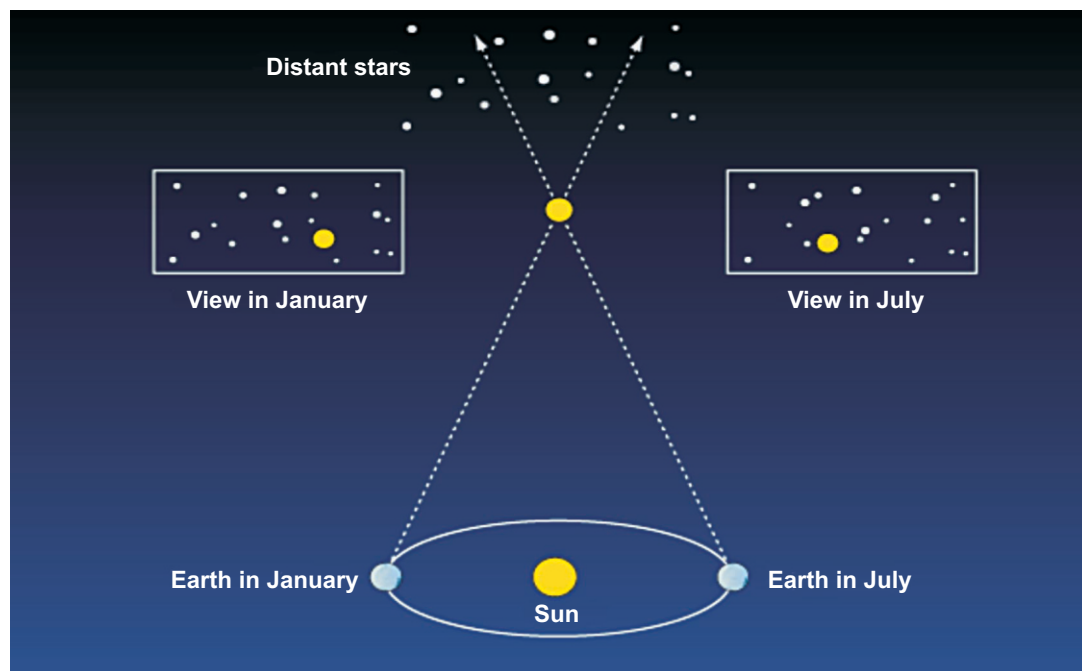



Fig 12.14: Change in the background as seen from two different positions

See figure (12.14), as the observer moves between the two positions, he would see the same tree, but it would appear to move against the background.

This effect can be used to measure the distances to nearby stars. As Earth orbits the Sun, a nearby star will appear to move against the more distant background stars, in the same way the tree appears to move against the more distant mountains in the diagram above. Astronomers can measure a star's position once and then again 6 months later and calculate the apparent change in position. The tiny shift in star's position in the sky is called its parallax.

Since this universe is so big, distances are no longer measured in meters or kilometers. Such distances to nearby stars are measured in 'light year' unit. The brightest star visible in the sky without a telescope is Sirius which has a distance of little more than 8 light years. It is interesting to note that light reaches us from the Sun in about 8 minutes and from Sirius in about 8 years.

DO YOU KNOW?

Effect of parallax can be observed very easily. Hold your hand out in front of you and look at it with your left eye closed, then your right eye closed. Your hand will appear to move against the background.

THE LIFE CYCLE OF STARS

- ✓ Explain the birth and death of our Sun.
- ✓ Describe the formation of Black Holes.

How long a star will live and how it will die, depends upon its mass at the time of its birth. Low mass stars have different endings than the violent and explosive ending of high mass stars. Our Sun is an average type low mass star among billions of other stars in our galaxy

Scientists believe the Sun is about half way through its lifetime. The Sun and all the planets of our Solar System began from a huge cloud of gas and dust about 4.5 billion years ago. These clouds are known as nebulae.

Proto-star phase:

Nabulae are made up of 97% hydrogen and 3% helium. Then something caused the cloud to contracts under its own gravitational forces and a ball of gas and dust is formed around which the material of gas and dust circled. At this time it is known as protostar. "Proto" means "early" or "before." So a protostar is the first step in becoming a full-fledged burning star.

Main Sequence phase:

The Sun spent about 100,000 years as a proto-star before the nuclear fire began at the core. Then it settled down into its current form. The most stable part of its life known as “the main sequence”. Generally, a star remains in this phase for most part of its lifetime burning hydrogen.

A star leaves its main sequence phase when it runs out of hydrogen and starts fusing helium and other elements. In 3.5 billion years from now, the Sun will be 40% more brighter than it is right now.

Red-Giant phase:

About 4.5 billion years from now the Sun will exit the main sequence. With its hydrogen exhausted in the core, the helium ash will become unstable and collapse under its own weight and start heating the core. The Sun will then grow in size and will become the Red Giant.

Planetary-Nebula phase:

Then about 250 million years the Sun will become unstable and begin losing its mass. After 500,000 years or more, only half of the Sun's current mass will remain and its outer layers will begin to form a planetary nebula.

White Dwarf:

The core of the Sun will cool towards a white dwarf. The planetary nebula will disperse in about 10,000 years, but the white dwarf will survive for trillions of years before fading to black.

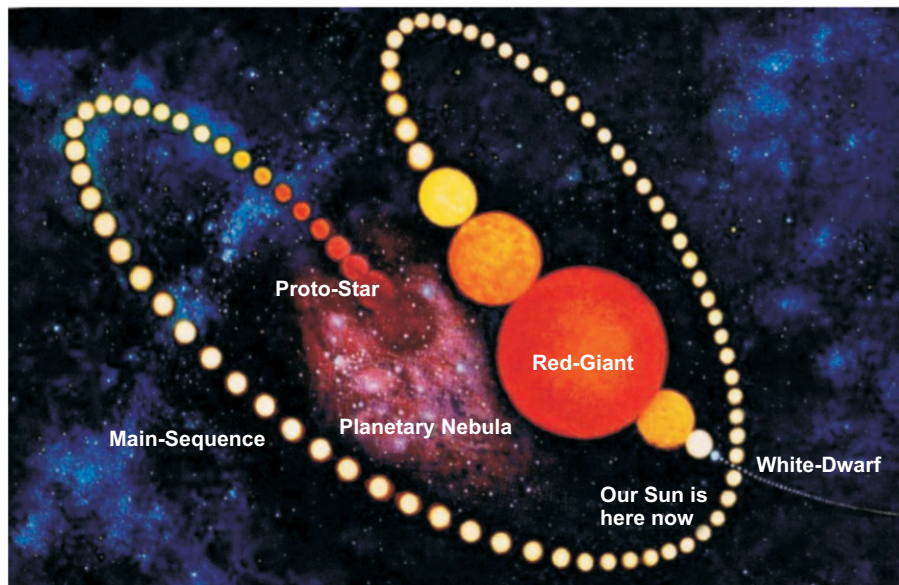



Fig 12.15: Life cycle of Sun-like stars

Black Holes and their Formation:

"A black hole is a region of space where matter has collapsed in on itself".

This catastrophic collapse results in a huge amount of mass being concentrated in an incredibly small area. The gravitational pull of this region is so great that nothing can escape not even light.

Fig 12.16: An artist conception of a black hole

A black hole does not have a surface, like a planet or star. They are invisible.
Black holes are formed when a heavyweight star, about 10 times heavier than the Sun, ends its life in a supernova explosion. What is left of the star collapses into an area only a few kilometres across. A supernova is an exploding star that blasts parts of the star into space.

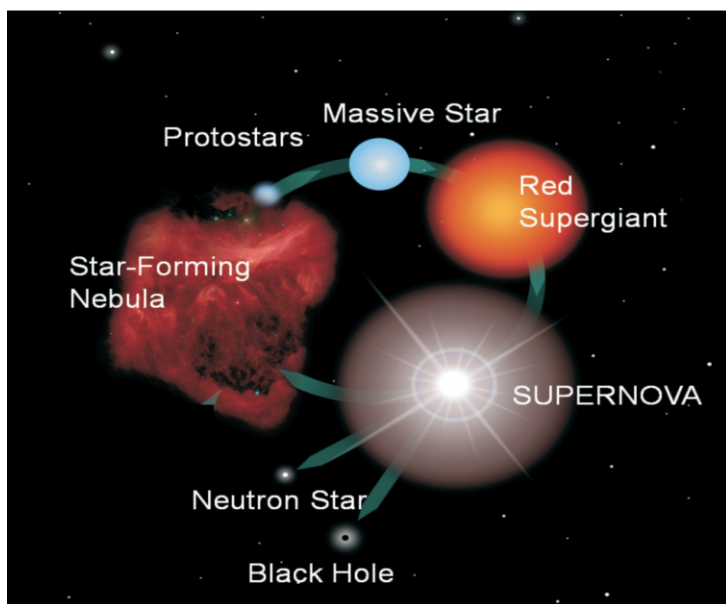



Fig 12.17: Life cycle of a massive star and formation of black hole

LOOKING AT STARS

- ✓ Identify major constellations visible at night in the sky.
- ✓ Explain the working of a telescope.
- ✓ Suggest safety methods to use when observing the Sun.

Constellations

A constellation is a group of stars in the sky that, when viewed from earth, create an outline of some recognizable shape or pattern. Modern constellations are mostly named after mythological themes such as gods, legendry heroes, creatures or structures. Although most constellations resemble the figures after which they are named, others are not as recognizable.

The constellations encompass the entire sky and only provide a visual reference for objects in the sky. There are a total of 88 constellations in the sky which are internationally recognized. Table below lists some well-known constellations.

Well-known Constellations		
Name	**Common Name**	**Famous stars in the Constellation**
Aquila	The Eagle	Altair
Bootes	The Hunter	Arcturus
Canis Major	The Big Dog	Sirius
Gemmini	The Twins	Castor, Pollux
Leo	The Lion	Regulus
Orion	The Hunter	Rigel, Betelgeuse, Bellatrix
Taurus	The Bull	Aldebran
Ursa Minor	The Little Bear	Polaris

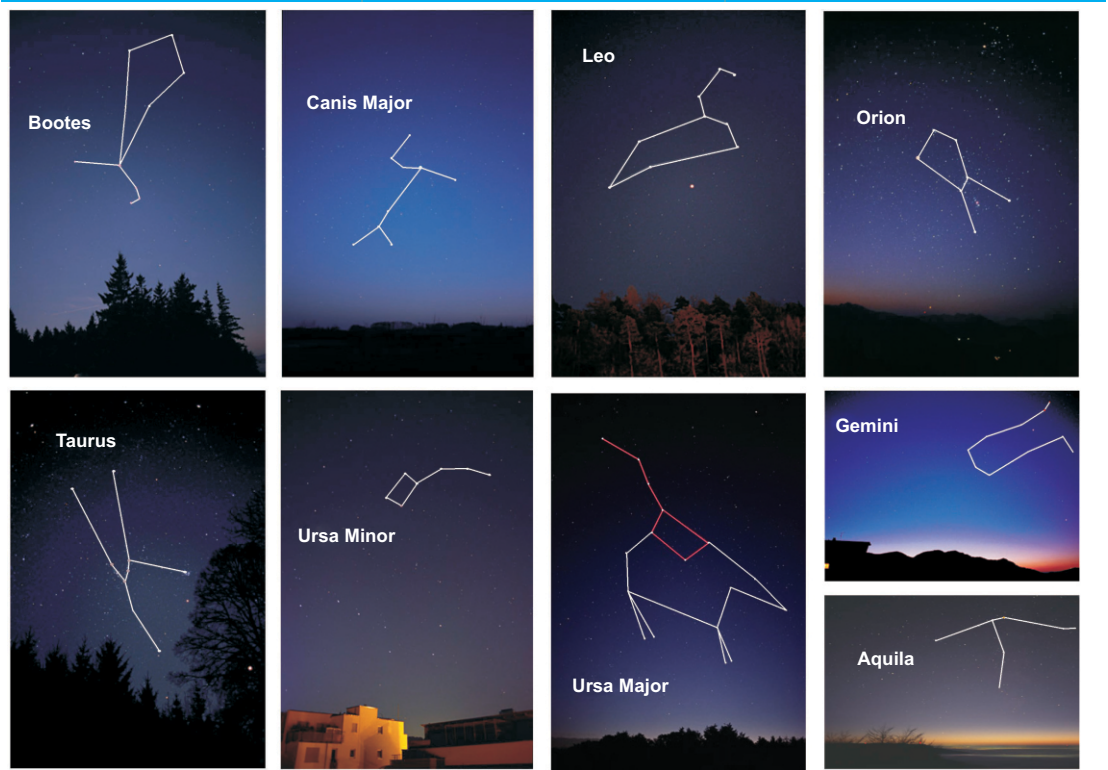



Fig 12.18: Constellation listed in table above as they can be seen in the sky. Lines are marked connecting stars which outlines the shape of the constellation

Activity 12.3 Making a Constellation Map

Material / Resources Required:

Drawing paper, black marker, cardboard, pencil, gum

Procedure:

1) Make 10 to 15 stars on cardboard and color them white and cut each star out from the cardboard.
2) Paste the stars on the drawing sheet as shown in the constellation figures of Orion and Ursa Minor.
3) Join the lines between the stars to make the pattern.
4) Now ask the student to think about some imaginary objects which they could make with the help of stars like hen, duck, bear etc.

How does a telescope work?

Telescope:

A telescope is an optical instrument used to see far remote objects like stars and planets.

Telescope gathers light from distant sources in such a way that an image can be produced. The first type of telescopes was made with glass lenses attached to handheld cylinders or tubes. Today, telescopes are made in many different ways, and used together with all kinds of scientific instruments to study the universe near and far.

There are two main types of telescopes: a refractor, which uses lenses to collect light, and a reflector, which uses mirrors.

Most refracting telescopes use two main lenses. The bigger lens is called the objective lens, and the smaller lens used for viewing is called the eyepiece lens. Refracting telescopes works as their objective lenses gather more light coming from an object than a human eye collect on its own and focuses it to a point. Then the eyepiece lens magnifies image of the object which can be seen by viewer as brighter, clearer and magnified image.

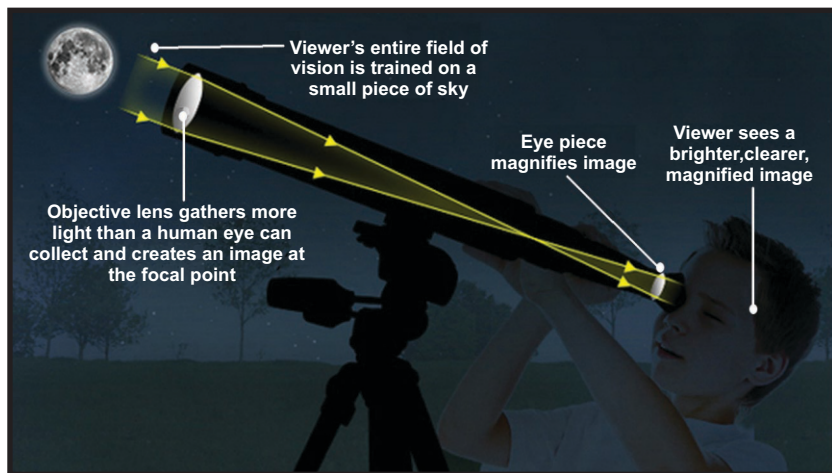



Fig 12.19: Working of a refracting (lenses) telescope

Refrecting telescopes have curved mirrors which served to collect incoming light from objects in the sky and are called objective mirrors. It bends light and makes parallel light rays converge to a focus. However, there is a secondary mirror in the telescope which directs the incoming focus light rays to eyepiece from where objects can be seen.

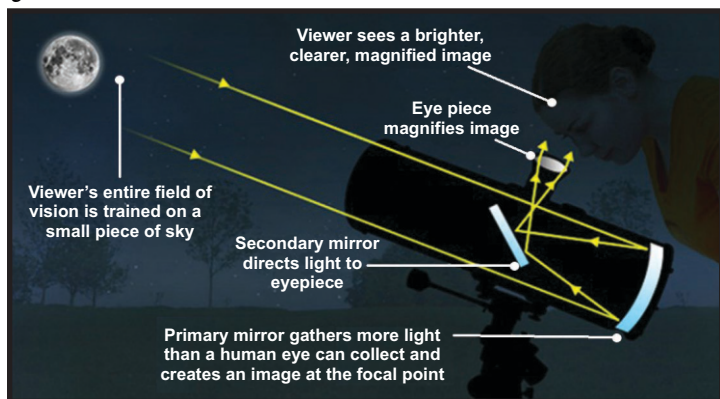



Fig 12.20: Working of a reflecting (mirror) telescope

Safety Methods when observing the Sun:

The Sun is so bright that prolonged, direct exposure can cause permanent damage to the retina, leading to loss of vision or blindness. To observe the Sun safely, more than 99% of the Sun's light must be filtered before it reaches eyes. One should never view the Sun with the naked eye or with any unfiltered optical device, such as binoculars, telescope, regular sun glasses etc.

Special filters should be used to cover up the objective lens of the telescope.

Galileo, the scientist who invented the telescope, looked at the Sun through a telescope, suffered permanent eye damage.

One safe way to observe the Sun is to project an image of the Sun through a telescope or binoculars onto a white screen or any other plain surface. This is an indirect way of observing the Sun.

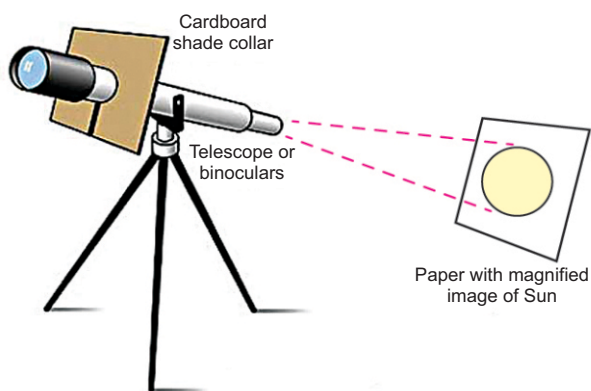



Fig 12.21: Projection method for observing the Sun

Fig 12.22: Special solar glasses for observing the Sun

Summary

- The scientific theory that describes the origin of the universe is called the Big Bang Theory.
- The universe began to exist as single point and it has been expanding ever since.
- The most convincing evidence confirming the Big Bang theory is the Cosmic Microwave Background (CMB) radiations.
- Stars are huge balls of gas made from hydrogen, helium and other elements producing light, heat and other forms of energy.
- Colours of stars are due to their temperature. Blue stars are hotter than red and orange stars.
- A galaxy is a vast collection of stars, gas, dust and other form of matter which are bound together gravitationally as a unit.
- Galaxies are generally grouped by their appearance into spiral, elliptical, lenticular and irregular.
- Parallax is the apparent displacement of an object because of a change in the observer's point of view.
- Life stages of a star are Proto-star, Main Sequence, Red-Giant, Planetary-Nebula and White Dwarf
- Black hole is a region of space where matter has collapsed in on itself.
- A constellation is a group of stars in the sky that, when viewed from Earth, create an outline of some recognizable shape or pattern.
- Refractor telescope uses lenses to collect light and a reflector telescope uses mirrors.
- The Sun emits dangerous radiation. Safety measure must be taken before viewing the Sun.

Review Exercises

1. Fill in the blanks with a ppo piate words given below.

hydrogen,	spiral,	higher,	matter,	stars,	elliptical,
dust,	light,	Origin,	helium,	gas,	

i) The scientific theory that describes the __________ of the universe is called the Big Bang.

ii) Stars are huge balls of gas mainly consist of ______ and _____.

iii) Blue stars have ________ temperature than orange and red stars.

iv) A galaxy is a vast collection of ______, _______ and ________.

v) A lenticular galaxy is an intermediate form of ________ and ________ galaxies.

vi) Black hole is a region of space where _______ has collapsed on itself.

vii) A telescope is an instrument that gathers ________ from distant sources.

2. Circle T for True and F for False state. Provide a correct statement for the False Statement.

i) The universe is 10 billion years old.

ii) CMB stands for Cosmic Matter Blue radiations.

iii) NASA launched COEB satellite in 1992.

iv) The Sun has temperature of around 6000 degree Celcius.

v) The named "Arcturus" is a hot blue star.

vi) Earth galaxy is called "Milky Way".

vii) Einstein proposed a way to classify galaxies.

viii) The Sun is about 15000 light years away from the center of our galaxy.

ix) The final stage of a Sun-like star is a black hole.

x) Constellations provide only a visual reference for the objects in the sky.

3. Write down the short answers to the following questions.

i) What type of a star ends its life cycle as a black hole?

ii) What is a light year?

iii) Define the term "constellation".

iv) On what factors does the brightness of a star depend?

v) What are Cosmic Microwave Background radiations?

4. Write down the detailed answer of the following questions.

i) Explain the Bing Bang theory about the origin of the universe.

ii) Explain the stages of life-cycle of a low mass star.

iii) Describe the types of galaxies.

iv) How do we measure distances to nearby stars.

v) Explain the birth and death of our Sun.